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THE CHICAGO RIVER TUNNELS will have to be lowered to give the river a navigable depth of 26 ft., as authorized by Congress, instead of 17 ft., as at present. Plans for this work have been prepared by Mr. John Ericson, City Engineer. In the Washington St. tunnel the flat roof would be lowered 12 ft. 6 ins. at the deepest part, increasing the approach grades from 6.37% to 7.87%. In the Van Buren St. tunnel, a flat roof would be built 13 ft. below the crown of the present arched roof, and the floor lowered correspondingly, increasing the approach grades from 10% to 11.06%. These approaches already have racks gearing with ratchet brakes on the cars. The La Salle St. tunnel would be treated in a similar way. The city is very anxious to have this work done, but will require the street railway companies to pay for it, as they are the sole users of the tunnels. It is claimed that the work can be done with little interference with traffic, and that by increasing the approach grades no extension of the approaches will be necessary, while the grades will be quite practicable for cable and electric traction. The engineer has also reported that a wide tunnel to connect the North and South boulevard systems would cost $6,000,000, instead of $2,000,000, as suggested by the promoters, but that two smaller tunnels, side by side, could probably be built for the latter sum. The viaduct proposed for the same purpose would involve an enormous expense for the purchase of land on each side of the river. It is pointed out that the city has no money available for either scheme, but that the double-tunnel plan is the most practicable.

THE BAKER ST. AND WATERLOO TUNNEL under the Thames, in London, is meeting with trouble in the form of a deep "fault" in the clay stratum. A water-bearing section will have to be penetrated by the shield, says the London "Daily Mail."

THE DISMAL SWAMP CANAL, as deepened and generally improved by Sandford & Brooks, contractors, under Alexander Brown & Sons, of Baltimore, as financiers, will be formally opened to traffic on Oct. 14.

THE MARYLAND AND DELAWARE PENINSULAR Canal project is to be again brought before Congress, after lying dormant for some years. The promoters now argue that Newport News and Norfolk, in their rapid growth, threaten the supremacy of Baltimore as a shipping port. But some of the Baltimore papers doubt whether the new canal would have any serious affect upon this commercial problem, even if made capable of passing large vessels.

THE CARDENAS-MENOCAL CONCESSION for a canal across Nicaragua, owned by the Maritime Canal Co. of Nicaragua, expired on Oct. 9, and the Eyre-Cragin concession, owned by the W. R. Grace syndicate, became the only valid existing concession for a Nicaraguan ship canal.

THE 25-FT. CHANNEL TO THE PORT OF PORTland, Ore., says the "Oregonian" of that city, is steadily progressing, and vessels drawing 23½ ft. now pass without delay. At the mouth of the Willamette there is now a channel 200 ft. wide and 25 ft. deep at low water. The Port of Portland Commission is now cutting a straight channel through Cathlamet Bay, including in the plan a training dike 19,700 ft. long, which may have to be extended several thousand feet further before the old channel can be safely abandoned. Since its organization in 1891 this Commission has received from the tax levy and sale of bonds $678,919, and has expended all of this in dredging and building about eight miles of dikes. A movement is already on foot to deepen ultimately the channel to 30 ft.; but the citizens of Portland claim that the government should do this work, and they have been forced to personal action only by the extreme slowness of government work in that region, as exemplified in the improvement of the Columbia River.

THE 30-FT. CHANNEL PROJECT FOR PHILADELphia, as presented by the late Board of Engineer Officers, is approved by the Secretary of War, and the $500,000 voted by the last Congress, subject to the decision of this board, is now available. Lieut-Col. Raymond, U. S. Engineer Corps, will probably ask for bids about Oct. 6; and the whole $500,000 will be expended in removing Dan Baker Shoal, 47 miles below Philadelphia.

THE SACRAMENTO RIVER RECLAMATION, now in progress, contemplates the expenditure of about $10,000,000 in controlling the winter floods from the slopes of the Sierra Nevada Mountains through about 200 miles of valley. These lowlands are nearly 40 miles wide, and with a 23-ft. rise in the river at Sacramento this country is often flooded for its whole width. The river is now being narrowed to a uniform width of 1,200 ft., and is being straightened so that its velocity and transporting power will be increased. At the work just completed at Newtown Shoals, five lines of spur dikes have been built, about 800 ft. apart and over 1,000 ft. long each, projecting into the stream. These dikes are made of brush mattresses and piles, riprapped with cobblestone, at a cost of about $40,000. The effect already secured is the closing of an old slough and the deepening of the river channel 6 ft. At Elkhorn Landing a concrete weir dam has been built, about 2,000 ft. long and with the crest about 4 ft. below the river bank. A system of these weirs will be constructed with the purpose of diverting surplus water into a by-pass, or waterway paralleling the river for 38 miles. This conduit will carry about 130,000 cu. ft. per second, and will reduce the 1,000,500 acres, now subject to overflow, to 46,400 acres. The legislature of California, in 1897, appropriated $300,000 towards this work, and this sum is to be added to each session.

THE ATLANTIC CONTRACTING COMPANY'S CONtracts for work on the Tybee breakwater, at the mouth of the Savannah River, and on the Cumberland Sound jetties were formally annulled by the government on Oct. 4. These are the contracts concerning which Capt. Carter was convicted of having conspired with the contractors. Work upon these contracts was discontinued nearly two years ago. The Cumberland Sound contract amounted to $2,235,000, a large part of which was for brush mattresses, at $1.10 per sq. yd. The contractors had received $345,000 of this at the time that work was suspended.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Lehigh Valley R. R., at Bear Creek, near Mauch Chunk, Pa., on Oct. 2. A locomotive, running at a high rate of speed, jumped the track and plunged over the retaining wall onto the east-bound track of the Central R. R. of New Jersey. Immediately thereafter a coal train on the latter road crashed into the wrecked engine. Three men on the first engine were killed.

THE STEAMSHIP "KAISER FRIEDRICH," of the Hamburg-American line, in making her first trip across the Atlantic in charge of her new owners, ran aground at Long Branch, N. J., on Oct. 9, within a few rods of the spot where the "St. Paul," of the American line, was stuck fast in 1895. Thick weather had prevented the taking of observations for two days, and the vessel was carried to the south of her true course. On the morning of Oct. 9 she was steaming at reduced speed through a fog when the land was discovered close ahead. The engines were reversed, and the vessel's headway was checked so that the bow struck the beach with hardly a perceptible shock. The water surging forward with the vessel and the backwash from the propellers was sufficient to wash away the sand from the bow, so that the vessel was at once backed off into deep water by her own propellers and suffered no damage from her contact with the beach. The vessel is one of the largest steamers afloat, being 600 ft. long with 64 ft. beam, and a displacement at 28 ft. draft of 17,000 tons. She was fully described in Engineering News of June 23, 1898.

THE HAVANA FLOATING DOCK has been sold by the Spanish government for $600 to a syndicate of Vera Cruz merchants. Several New York firms have been asked for terms for conveying the dock to Vera Cruz.

THE STREET CAR FENDER ORDINANCE in Chicago went into effect on Sept. 1, 1898. All the street cars in the city were equipped by May 1, 1899. Up to Sept. 1, 1899, according to the Chicago "Record," 79 persons had been struck by cars carrying fenders. Of this number 37 were picked up, of whom 13 were adults and 24 children, and 17 of those picked up were uninjured, 15 slightly injured, 2 had legs fractured and 1 case was fatal. In 22 cases the fender passed over the person struck, 11 being adults and 11 children. One child was instantly killed, and five persons sustained fatal injuries. Of the remaining 16, one had both legs broken, three had a leg or ankle fractured, four are noted as seriously injured and seven as slightly injured. One escaped unhurt. Twenty persons were knocked down or pushed aside by the fender. Two of the number had a leg or ankle fractured, one had an arm broken, 15 were slightly injured and two were uninjured. The total percentages are: 25% uninjured, 47% slightly injured, 19% seriously injured and 9% fatally injured. Six types of fenders are in use, all of the "basket" pattern.

RESPONSIBILITY FOR DAMAGES BY ELECTROLYsis has been voluntarily assumed by a street railway company in accepting franchises in Yonkers, N. Y. The franchise contains the following provision:

> The said railroad company agrees so "to construct its trolley wires and lines where now built or hereafter built . . . that any damage by reason of the escape of electricity through the wrongful act, carelessness, or negligence of such company, shall be paid for by the Yonkers Railroad Company."

The insertion of this provision in the franchise is said to be due to the Yonkers Board of Water Commissioners, acting on the recommendation of Mr. Fremont Wilson, Consulting Engineer of the Bureau of Electrical Inspection of the New York Board of Fire Underwriters.

THE REPAIR OF STREETS BY SURFACE RAILWAY companies, to a defined width outside the tracks, is made compulsory by a decision of Justice Lynn, affirmed by the Appellate Term of the Supreme Court of New York, in the cast of Marcus Simon against the Metropolitan Street Railway Co. A horse belonging to the plaintiff was injured by stepping in a hole contiguous to one of the rails of the Metropolitan Co. The defense of the company was that it was not liable to damages, under section 98 of the Railway Law, which makes it the duty of the company to keep the street in permanent repair between and 2 ft. outside of the tracks, because no notice of the condition of the street was given to it by any local authority. The court decides that such notice is not a condition precedent to the performance of this duty by the railway company; and a neglect of the duty assumed under the railway law makes the company liable in a civil action for damages sustained by one of the public.

A 60-MILE ELECTRIC RAILWAY is to be constructed between Toledo and Norwalk, O. The proposed road, starting from Toledo, will run in a southeasterly direction, passing through Genoa, Woodville, Hesseville, Fremont, Clyde, Bellevue, Monroeville, and thence to Norwalk. The distance traversed will be over 60 miles, 31 miles of which is on the Maumee & Western Reserve turnpike in Sandusky county. The engineers and contractors for the entire equipment are Westinghouse, Church, Kerr & Co. The central power house will be at Fremont, near the center of the line, and three-phase alternating current will be employed for transmission, which will enable the whole line to be supplied from this station. Steam will be furnished by five 300-HP. Babcock & Wilcox boilers, equipped with Roney mechanical stokers and coal and ash-handling machinery. Two 4,000-HP. Worthington jet condensers will be provided, also hot feed-water and a good draft will be secured by a Westinghouse mechanical draft and economizer system, while the feed water will be treated before being pumped into the boilers to remove the scale forming properties. The exhaust steam from the auxiliary engines will be used for heating the feed water on its way to the economizer. Four Westinghouse Columbian-type engines will be directly connected to four 500-K-W. Westinghouse engine-type three-phase generators. Two 9 and 15 × 9-in. Westinghouse single-acting compound engines will be directly connected to two 30-K-W. exciter generators. In addition to the Fremont central power station, six sub-stations will be built nearly equidistant from each other along the line of the road, while a seventh sub-station will be provided within the power house at Fremont. The current generated at the central power station will be raised by transformers and transmitted at about 15,000 volts to the sub-stations, and there lowered by step-down transformers and changed by rotary converters from alternating to direct current for feeding the trolley lines. Each sub-station will be equipped with three step-down transformers and two rotary converters, together with a switchboard and controlling apparatus, and will be connected by feeders with the trolley line. By adopting the alternating current it is possible to supply the entire 60 miles of road from one central power station, and to reach out to supply feeders in all directions, or to extend from the terminals. The saving in copper wire by using a high-tension transmission is estimated at more than $100,000. The sub-stations will be arranged so that they will be operated with very little extra attention, being combined with passenger and freight stations at most points. The roadbed will be very substantially constructed, as it is intended to run the cars at a speed upwards of 40 miles an hour.

FILLING TRESTLES BY THE HYDRAULIC METHOD.

The hydraulic process of filling in timber trestles, to replace these structures by solid embankments, was described in two articles in our issue of Nov. 28, 1895, and since that time considerable work of this kind has been carried out on the Canadian Pacific Ry. and the Northern Pacific Ry.

FIG. 1.—EXCAVATING JET FOR FILLING IN THE MOUNTAIN CREEK TRESTLE; CANADIAN-PACIFIC RY.
P. A. Peterson, M. Am. Soc. C. E., Chief Engineer.

The accompanying cuts represent the filling in of a trestle at Mountain Creek, B. C., on the Canadian Pacific Ry., the trestle being 1,611 ft. long, with a height of 145 ft. over the creek. Water is brought down by a steel pipe line and thrown against the hillside in powerful jets, as in hydraulic mining. This is shown in Fig. 1, which shows the end of the trestle, with the pipe line, the water jet, and the great excavation which has been made. In the center is the flume which carries the stream of water and debris to the site of the bank. Fig. 2 shows the end of the flume and the two partly completed banks, with the stream of water and debris falling from the flume upon the bank on the far side of the trestle. The end of the flume is shifted as desired to level up and distribute the material.

The bank looks as if it were covered with riprap, but this appearance is due to the rows of old ties which are laid along the top of the slope, forming shallow dams to retain the water in a pool and so ensure settlement of the finer material which it brings down. They also prevent the water from flowing away with such force as to cut the face of the slope. Brush of spruce, pine or cedar is sometimes used for this purpose, when it can be obtained more readily than old ties.

The trestle was originally built with two timber truss deck spans at the center, supported on timber trestle towers, with masonry pedestals. A single steel deck span on steel towers has since been erected, as shown in Fig. 2 (which also shows the old abandoned center pier). It is proposed to put in two additional spans on each side of the center span. The piers for these will be built on the hydraulic-filled bank, which is said to be more compact than any natural earth foundation, and which can, therefore, be built upon with entire safety. For the photographs and particulars of the work we are indebted to Mr. P. Alex. Peterson, M. Am. Soc. C. E., Chief Engineer of the Canadian Pacific Ry.

The same general practice is followed on the Northern Pacific Ry., and the following information has been furnished by Mr. E. H. McHenry, M. Am. Soc. C. E., Chief Engineer. This, it will be seen, fully endorses Mr. Peterson's statement as to the solidity of the bank. The water is diverted from the most convenient mountain stream, and carried alongside the mountain, parallel with the line of track, and usually about 200 ft. above the same, where it is taken for use in the hydraulic "monitor" or "giant" employed in this work. The jet used is from 3 to 4 ins. diameter, depending upon the amount of water available. The material is carried to the trestle in ordinary rectangular box flumes, and the discharge outlet is varied from time to time to meet the requirements. There is nothing special in the process, apart from the building of the levee, or dam, around the edge of the bank. This is constructed of alternate layers of earth and straw or hay. The tough marsh hay is found the best for this purpose. The material is spaded from the inside and the hay is distributed by a man walking along the dike and shaking the same down loosely. The next layer of material compacts it thoroughly. While this may appear to be quite pervious, it is, in fact, very quickly puddled by the action of the water.

The embankment is constructed to within three or four feet of its finished elevation, and the fill is then completed by work trains. The banks are remarkably solid and no subsidence has ever been observed other than that arising in some cases from the compression of the original soil on which it rests. The hay or straw on the levee has the incidental advantage of protecting the newly-made bank, not only during the first year, but subsequently, as the seeds germinate and form a sod. The cost of the process varies with the local conditions, as may be imagined, and ranges from 1½ cts. per cu. yd. to 20 or 25 cts. Mr. McHenry states that the Northern Pacific Ry. has filled some 30 trestles in all on the Cascade Mountains, and the final completion of the work will be reached at the end of the present year. The average cost of several million cubic yards does not exceed 6 cts. per cu. yd. The system has been peculiarly satisfactory in that the track is not occupied by work trains. While the process is cheap, it is somewhat slow, the average daily result of a small working crew of five men and one hydraulic nozzle being between 500 and 1,500 cu. yds., but where water is abundant, a number of crews can be worked simultaneously.

It is interesting to note that incidentally, in connection with the filling of the trestles, this company has converted a tunnel into an open cut between two bridges, at a very slight addition to the cost of the work under normal circumstances. The material excavated from above the tunnel formed the filling for the trestle approaches.

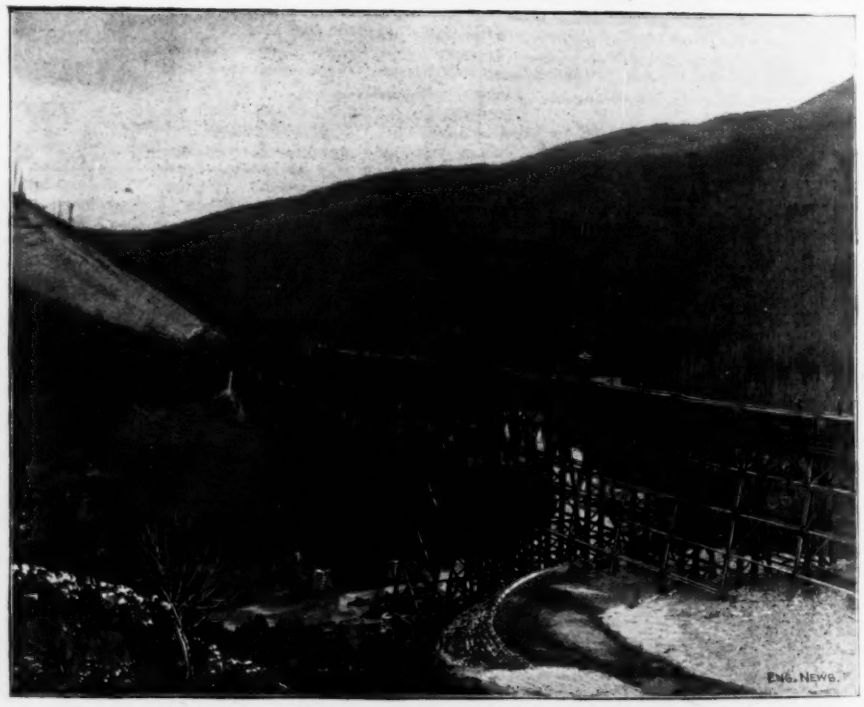

FIG 2.—VIEW OF MOUNTAIN CREEK TRESTLE, CANADIAN-PACIFIC RY.; SHOWING THE PARTLY COMPLETED BANKS TO REPLACE THE TRESTLE APPROACHES.

THE FUEL ECONOMY OF ENGINES IN ELECTRIC RAILWAY POWER STATIONS.*

By R. C. Carpenter, M. Am. Soc. M. E.†

In the following paper are given the results of 25 tests of electric railway power stations, which have been made during the past eight years under my supervision, by especially trained students in advance work in Cornell University.

The tests which are cited were made under the ordinary conditions of operation peculiar to the system referred to. In every case the results were doubtless affected by the machinery employed, the method of operating the station and by the varying and continually changing load produced by irregularities in loading and moving of cars.

The tests show the fuel consumption of several classes

*A paper read before the annual meeting of the New York Street Railway Association.

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engines, operating under the usual condition of power-house work. There is shown a variation in the fuel economy by engines of the same class, operating in different stations, which in some instances is of considerable amount. This is probably to be expected, for it is well known that the economy is affected to a great extent by variations in load, since an engine fully loaded is in general much more economical than one partly loaded; no duty throws on an engine a more variable load than street railway work. A certain amount of the variation in coal per horse-power, as shown by the tests, may be accounted for by individual differences due to poor or good firing; this does and often does, make 20% or more difference in fuel economy, and this condition affects the uniformity of the results about in the same proportion. The effect of employing different classes of engines is also well marked. The fuel consumption of different classes of engines is doubtless the most interesting and practical part of the investigation. If we can learn from the tests the probable fuel consumption of each class of engine, we can draw conclusions as to the saving which might be produced by change of power, and we can also predict with certainty the fuel charges for different classes of stations.

Tests of Simple, Non-Condensing, Slide-Valve, Automatic Engines.

The summary of the tests of the simple, non-condensing engine shows on the whole an economy of steam and coal nearly equal to that usually attained with engines of this class in any work. The most probable values indicating an average consumption of 34.3 lbs. of steam and 4.63 lbs. of actual coal per I. HP. per hour. In tests made by the writer, with an engine of this class, operating with a steady load, the best results at the normal load corresponding to about ¼ cut-off, was slightly over 27 lbs. of steam per I. HP. per hour, the steam consumption was greater either with a lighter or heavier load. The accompanying diagram exhibits the results of a series of tests made on an automatic slide-valve engine running non-condensing. Each test was continued sufficiently long at a given load to obtain the water consumption for that condition. The results are shown in the diagram. When the load is light the steam per horse-power per hour is very

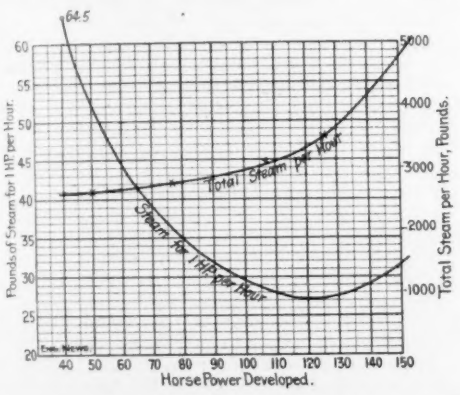

Diagram Illustrating Variation in Steam Consumption, with Changes of Load. Simple Non-Condensing, Straight-Line Engine, 14 × 16 ins.; Steam Pressure, 120 lbs.; Speed, 210 r. p. m.

great, when the load is normal the steam consumption is lowest, when very high, the steam consumption per I. HP. is increased. The total steam used per hour increases faster than the increase of load. The curve indicating steam per I. HP. per hour shows slightly over 27 lbs. at 120 HP., nearly 30 lbs. at 150 HP., 44 lbs. at 60 HP., and 64.3 lbs. at 40 HP.

Thus it is seen that a comparison of the results of the test of the automatic simple, non-condensing, engines in actual power-house work with those obtained under best conditions, is in many respects favorable. The average results of all the tests show a steam consumption only about 25% higher than obtained with this class of engine working under most favorable conditions.

This corresponds by the diagram to the results obtained with the engine tested at about 80 HP. or at two-thirds its rated capacity. The average load as compared with the capacity of the engines in the various power house tests was 54.2%, which would correspond by the diagram to a steam consumption at 41 lbs. per HP. hour.

Tests of Non-Condensing Simple Corliss Engines.

Three stations only were tested, which were using non-condensing simple Corliss engines. These three stations show fairly uniform results both as to steam and coal consumption, and as was the case with the simple slide-valve engine, the results closely approximate the best results to be obtained with that class of engines. Thus, while this class of engines might produce a horse-power under favorable conditions of loading for an expenditure of 23 to 25 lbs. of steam used, the tests show an average steam consumption of 28.3 lbs. of steam per I. HP. per hour, the average load being slightly over one-half of the rated capacity. The coal per I. HP. per hour averaged 3.45 lbs. The evaporation per lb. of combustible varied considerably, which was due in part to the variation in calorific value of the coal used.

The Non-Condensing Compound Engine.

The data obtained relating to this class of engine is limited, as but four tests of power stations were made in which such engines were used, and two of these tests were made when both simple and compound engines were running. The results in these two do not differ essentially from those obtained with simple engines and previously recorded. The other two tests were made on non-condensing compound engines, working under fairly favorable conditions. One of them did not show better coal or steam consumption than many of the tests recorded for simple non-condensing engines. It would hardly be safe to draw a general conclusion from the results in the table regarding the compound non-condensing, as compared with the simple non-condensing engine for railroad purposes, but such conclusion as could be deduced would be but slightly in favor of the compound non-condensing engine.

Some additional information was obtained on this question by a test which was made on both simple and non-condensing compound engines, each kind being tested separately. The test on three simple engines showed an average steam consumption of 31.8 lbs. of steam per I. HP. per hour, and a fuel consumption of 5.38 lbs. of coal. The test on one compound non-condensing engine (24×48×48) 1,200 HP. showed a steam consumption of 30.37 lbs. of steam and a fuel consumption of 4.93 lbs. of coal per I. HP. per hour. The actual evaporation per lb. of combustible from and at 212° being in the test of the compound 7.75 lbs., and in the tests of the simple engines 7.83 lbs. Reducing the results for uniform evaporation, the two tests would indicate that the compound as compared with the simple non-condensing was 9.4% more economical in use of coal, and about 5.5% more economical in use of steam.

The compound non-condensing engine is much less economical, as shown by these tests, when employed in power-house work where the load is variable than when used for a steady load. Thus I have tested a compound non-condensing engine of this class working with a steady load and with about the same steam pressure as in the cases cited, and found a steam consumption under the best conditions of loading of 22 to 23 lbs. of steam per I. HP. per hour, which is nearly 33% better than shown by the same class of engines in power-house work.

We have seen that the simple non-condensing engine performs its work in a railroad power house under conditions of varying load, with an average steam consumption only about 25% higher than the best average record for its class of engines with a steady load. The compound non-condensing engine requires on the other hand, however, nearly 40% more steam than when working under best conditions with a steady load. From this limited data it would appear that the compound non-condensing engine is only slightly better than the simple non-condensing, and except under extreme conditions not sufficiently better to warrant its use.

No stations were tested using Corliss non-condensing compound engines, neither were any tested using simple condensing engines, and no engines of this class are known to the writer to be in use in railroad power stations.

The Compound Condensing Slide-Valve or High-Speed Automatic Engine.

The average results of the tests which were made in power stations using automatic engines of the above type, show a steam consumption of 23.96 lbs., and a coal consumption of 3.41 lbs. per I. HP. per hour. It we reject the three highest values as given in tests 3a, 18 and 21,

TABLE I.—Summary of Tests of Compound Condensing Slide-Valve or High-Speed Automatic Engines. Steam Pressures, 100 to 130 lbs.

No.	HP. of engine.	Per I. HP. hour—Steam.	Per I. HP. hour—Coal.	Mean observed HP.	Per ct. of mean HP. to capacity.	Boiler evaporation, lbs.	Kind of coal.
3a..	600	29.4	4.43	174	29	10.38	3 parts Anth. 1 part Bitu.
3...	600	23.2	3.50	190	32	9.93	1 part Bitu.
8...	400	20.2	3.14	154	38	8.29	Ohio Bit.
8b..	400	16.7	2.40	180	45	7.75	Ohio Bit.
13...	250	24.6	2.95	86	34.5	10.51	Bit. Penn.
16...	350	22.7	3.41	164	47	9.50	Ant. Pea.
18...1,200		25.6	3.61	904	75	10.58	Pea Penn.
21...	400	29.3	3.81	188	47	10.23	Bitumin'us
Ave....		23.96	3.41	...	..	9.64	
Ave.*....		24.26	3.40	...	..	9.82	
Ave.§....		22.7	3.25	...	..	....	

*Except 3a and 8b. §Omitting 3a, 18, 21 and 8b.

and the lowest result as given in 8b, we shall have for the average 22.7 lbs. of steam and 3.25 lbs. of coal per HP. per hour, which can doubtless be assumed to be most probably correct for this class of engine.

Most of the makers of engines of this class will guarantee them to produce a horse-power per hour for a consumption of 18 lbs. of steam under favorable conditions of loading, and engines of this class have in several instances produced a horse power for less than 15 lbs. of steam. It will be noted that the best results with engines of this class was 16.7 lbs. of steam per I. HP. per hour, and 2.4 lbs. of coal per HP., which was obtained with an engine of 400 HP. of the four-valve type. The effect of the variable load and other conditions due to railroad work is to affect the economy adversely by 30 to 40% as compared with the best results with a steady load.

Compound Condensing Engines, Corliss; Greene and McIntosh & Seymour Types.

The average results of the tests made on the compound condensing Corliss engines and other engines with similar valve-gear, including McIntosh & Seymour and Greene, show a steam consumption of 18.8 lbs., and a coal consumption of 2.6 lbs. per I. HP. per hour. Omitting test No. 10 for the reason that the coal was of a poor quality, and the evaporation low, the average becomes 18.25 lbs. of steam and 2.36 lbs. of coal per I. HP. per hour. The steam consumption of this class of engines working with a good load can safely be taken as 15 lbs. or less per I. HP. per hour, in which case the actual results in power-house practice exceeds the results when the load is steady, by slightly over 20%.

A study of these latter tests shows a higher evaporation per lb. of coal than was obtained in power houses using the cheaper grade of engines. This is probably to be explained by the fact that a better grade of engines and firemen are employed to operate stations of this class, as compared with those using cheaper machinery, although it may possibly be an accidental variation due to the fact that only a limited number of stations were tested in each class.

The average evaporation from and at 212° per lb. of combustible, was found to be as follows: For stations using the simple non-condensing engine, 10.26 lbs.; for stations using the compound condensing slide valve engines, 9.82 lbs.; for stations using Corliss compound condensing engines, 10.54 lbs. of steam. It is not easy to explain why the evaporation is better from stations using simple engines than from those using compound engines of the same class, as the average grade of employees is rather better in the stations using compound than simple engines; probably the variation is an accidental one due to the limited number of stations of each class tested. The average range in the variation of results of the evaporation tests for the stations employing the three classes of engines does not exceed 7%, and whether it can be accounted for or not, it will not seriously affect the conslusions.

Summary of Results.

A summary of the average results of these various tests is given in Table II. in such manner that the various classes of engines may be readily compared. The best results with each class of engines when sufficiently well marked is also given. A column giving the proportional value of the engine on the basis of coal consumption with a Corliss compound condensing engine placed at 100 is also given. A column giving the probable coal consumption per K-W. hopr is also appended.

TABLE II.—Summary of Average Results.

Class of engines.	Per I. HP.—Steam, lbs.	Per I. HP.—Coal, lbs.	Steam, best load, lbs.	Proportional value; engines.	Probable coal per K-W., lbs.
(A) Non-condensing.					
Slide-valve simple, ave...	34.3	4.63	30	53.1	6.90
Best result	31.6	4.61	..	....	....
Corliss simple, average..	28.3	3.45	25	64.5	5.65
Best result	26.9	3.01	..	....	....
Slide-valve, comp'nd, ave.	30.37	4.17	22	60.2	6.12
(B) Condensing.					
Slide-valve comp'nd, ave.	22.7	3.25	16	80.5	4.57
Best result	16.7	2.40	..	....	3.60
Corliss compound, average	18.2	2.36	15	100.0	3.64
Best result	14.5	1.80	..	....	....

Relative Economy of Various Types of Engines.

Assuming that the results of the tests which have been cited give average and best results for engines of the different classes tested when working under the conditions of street railroad work, it is easy to compute the probable yearly cost of each class of engine and by this means determine the relative value from a financial standpoint.

From Table II. it will be noted that the steam consumption per I. HP. per hour varies from 34.3 lbs. to 14.5 lbs. A boiler horse-power under the conditions of steam pressure supposed to exist would be about 30.4 lbs. of steam, although this amount would vary slightly, depending upon the temperature of feed water and upon the steam pressure. This computation would show that 1.13 boiler HP. would be required in case a simple slide valve non-condensing engine were used, while only 0.6 of a boiler HP. would be required for furnishing steam for the compound Corliss engine or engines of its type in order to supply them with the same relative amount of steam. This indicates that a considerably less amount of boiler power would be needed for the more economical engine than for the more wasteful one, and this fact tends to equalize the cost of a power station employing the different classes of engines.

From actual prices which have been quoted within the last six months the writer feels very certain that an engine of 500 HP., of good quality in its respective class, can be purchased and, under ordinary conditions, can be

TABLE III.—Cost per HP. of a 500-HP. Steam Plant.

Class of engines.		Non-condensing engines—Simple—Slide-valve.	Non-condensing engines—Simple—Corliss.	Non-condensing engines—Compound slide-valve.	Condensing engines,—Compound.—Slide-valve.	Condensing engines,—Compound.—Corliss.
Boiler HP. per engine HP.		1.135	0.933	1.00	0.75	0.602
Cost per HP.	Engine	$8.00	$12.00	$11.00	$11.00	$16.00
	Boiler	13.60	11.20	12.00	9.00	7.25
	Pumps and heaters	2.00	2.00	2.00	4.00	4.00
	Piping, etc.	5.00	5.00	5.00	6.00	6.00
	Total per I. HP.	28.60	30.20	30.00	30.00	33.25
Cost for 500 HP. plant		$14,300	$15,100	$15,000	$15,000	$16,625

erected complete on foundations for the figures which are given in Table III. A boiler horse-power is considered as worth $12 when erected for each class of engines. In view of the recent rise in prices, this may be somewhat low; but the results are comparatively true for each class of engine. The figures in the table do not include real estate, building or chimneys, which would vary largely with different conditions. Despite the fact that engines, pumps, heaters and piping will cost more per horse-power for the condensing than for the non-condensing engines, the total cost per horse-power does not differ greatly for the various classes of engines employed; this is due largely to the fact that a smaller boiler plant is needed with the more economical engine. It may be added that the cost of engines of larger units would be somewhat less per horse-power and the cost of those with smaller units somewhat greater per horse-power than the results shown in the table.

Taking the fuel consumption as shown by the average results and also the best results in the various tests mentioned, we can compute the yearly requirements in tons per horse-power for each class of engine. This has been done in Table IV., which is arranged to show the number of tons of 2,000 lbs. required per horse-power per day for a day of 12 hours, of 18 hours and of 24 hours. The fuel cost at $2 per ton per horse-power year for a day of 18 hours is taken as a basis of comparison of fuel costs of the various engines which have been tested. A day of 18 hours is believed to represent fairly well the average length of time which railroad engines are required to operate. It is also believed that $2 per ton is not far from the average price paid for coal by electric railways in New York. If anything, it is rather below than above the average price, and consequently lessens rather than exaggerates the proportional saving made by the most economical engine.

To the fuel cost of each engine must be added fixed charges of sufficient amount to cover interest and repairs, and this has been assumed to be in each case 8% of the cost. No account is taken of that portion of the operating expense chargeable to employees and oil, for the reason that there is no known reason why such charges should be essentially different for the best or for the poorest engine. The following table shows these various quantities computed for the different classes of engines. The last column in the table shows the sum of fuel costs and fixed charges, and is one which may be taken to represent the proportional yearly cost of each class of engine. By a study of the results in the latter column some interesting conclusions may be deduced.

First, as to the saving due to condensing water; we have only two results which can be compared to show the value of the condenser; these results are the cost of the compound slide valve non-condensing compared with the average value for the compound slide valve condensing. The results are, respectively, $29.54 and $23.76; the saving due to condensing is $5.78, which is 19.5% of the cost of running a non-condensing and 24.4% of the cost of running a condensing engine. The saving would seem to be nearly 20%, and, for reasons which have been already mentioned, would probably be more.

Second, the average yearly cost of engines of the compound condensing type with the Corliss, McIntosh & Seymour, or Greene valve gear, as compared with the simple slide valve engines, show a yearly saving of $14.69 per HP.

The difference in first cost of the power plant considered is $4.65, which is the excess in cost of the compound condensing Corliss type over the simple slide valve non-condensing. The saving in fuel and fixed charges is thus seen to be sufficient in a single year to pay 3.15 times the difference in cost between the cheapest and best power plant. Comparing in the same way the average yearly costs of fuel and fixed charges for the compound slide valve condensing engine and the compound Corliss condensing type, we find a yearly saving of $5.64 in favor of the better grade of engine. The difference in costs of the two plants is $3.25 per HP. in favor of the compound condensing slide valve engine. Thus, in a single year the saving on the fuel and fixed charges of the better engine as compared with the poorer will pay 1.73 times the difference in cost.

These figures would seem to show that no station can afford to purchase and operate the simple non-condensing engine of any type as compared with the compound condensing engine, and that the compound condensing engine of the best type and with improver valve gear, such as the Corliss, McIntosh & Seymour and Greene, and one or two other makes, although costing somewhat more, is so much more economical to operate that, taking all things into consideration, it gives much better financial returns than an engine of any other class. These financial returns are so much in their favor that unless other conditions are exceedingly unfavorable, these latter engines are the only ones which should be considered for power house work. This general conclusion, that the compound condensing engine of slow rotative speed and with the improved valve gear is much more economical to use than any other type for power house work, even when fixed charges are considered, is certainly the only one which can be adopted from the average results of the tests which I have quoted. This conclusion is noticeable from the fact that in a comparison of costs of different types of railway engines made by the late Dr. Charles E. Emery, he concluded that the compound condensing engine of the slide valve type and with cylinders arranged in tandem was, when fixed charges were considered, the more economical engine to use. The tests which I have referred to point to a different conclusion and indicate that the saving of the better type of engine will many times repay the extra expenditure of costs.

BOTTOM HAULAGE LANDING AT THE MAMMOTH MINE.

By Howard N. Eavenson, C. E.*

(With two-page plate.)

The Mammoth coal mine and coke plant of the H. C. Frick Coke Co. is situated in Westmoreland county, Pa., on the Sewickley Branch of the South West Penna. Railroad. The plant is one of the largest in the Connellsville region, having 510 coke ovens and two openings, a slope and a shaft; 199 of the ovens are at the slope and 311 of them at the shaft. The mine was first opened at the slope about 1884. The shaft was sunk two years later, and the mine was acquired by the present owners in 1889.

The slope is upon the eastern outcrop of the Connellsville coal seam, and the main heading is driven for a distance of 2,940 ft. to No. 14 and No. 15 face headings, or "flats." The shaft was sunk to No. 15 flat, 260 ft. to the right of the main slope heading. After a turn to the left, the main slope heading is continued beyond No. 15 flat as the main dip heading of the shaft to the face of the workings, a distance of about 5,000 ft. At various places throughout the mine the shaft and slope headings are connected, and the same system of ventilation is used, although, in the operation of the plant, all of the coal above No. 15 flat goes to the slope pit mouth, while all below it goes to the shaft bottom.

Two years after the sinking of the shaft a tail rope haulage system was installed in the mine, the engines being placed upon the surface, in the haulage engine house shown in Fig. 1. Two bore holes, shown at (A), were drilled, one on each side of the main slope, and the ropes were carried from the drums of the engine over rollers to two large sheaves at the top of the bore holes, and through the bore holes into the mine. From the bottom of the holes the pulling rope was carried in the center of the track into the mine, while the tail rope was carried at the side of the heading on small sheaves supported by posts.

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TABLE IV.—Fuel and Interest Charges for the Different Classes of Engines.

Class of engines.		Coal pr I. HP. per hr., lbs.	Tons of coal per HP. per year.—Day of 12 hrs.	Day of 18 hrs.	Day of 24 hrs.	Fuel cost per yr., 18 hrs. pr day, & $2 per ton.	Interest and depreciation 8%.	Total cost per year per HP.
Non-condensing engines	Simple slide-valve, average	4.63	10.14	15.21	20.28	$30.42	2.29	$32.71
	" slide-valve, best	4.60	10.07	15.10	20.14	30.20	2.29	32.49
	" Corliss, average	3.45	7.55	11.33	15.10	22.66	2.42	25.08
	" Corliss, best	3.01	6.59	9.89	13.18	19.78	2.42	22.20
	Compound slide-valve	4.17	9.05	13.57	18.10	27.14	2.40	29.54
Condensing engines.	Compound slide-valve, average	3.25	7.12	10.68	14.24	21.36	2.40	23.76
	" slide-valve, best	2.40	5.25	7.88	10.51	15.76	2.40	18.16
	" Corliss, average	2.36	5.17	7.74	10.33	15.48	2.64	18.12
	" Corliss, best	1.80	3.94	5.91	7.88	11.82	2.64	14.46

Old Shaft Bottom Landing.—No. 15 face heading was double tracked from the main heading to the shaft, a distance of 260 ft., and was used as the shaft bottom landing. The method of operation was as follows, referring to Fig. 1: The loaded trip, coming up the main heading, was pulled to the bore holes, and then allowed to drop back into the shaft bottom. The grade here was quite steep, about 2.2%, and the wagons ran easily to the bottom of the shaft and were caught. The empty wagons, after being pushed off the cages, ran by gravity a short distance, and were then coupled together by two boys. When about ten empties were together, the trip was hauled by a mule past the point (B), where a rope was attached to the back end of the trip, and it was hauled through the parallel to the shaft bottom, and out to the point (A). The rope was operated by a pair of geared engines, with cylinders 7 × 10 ins., set on the side of the shaft bottom near the point (A).

This araringement was satisfactory when the haul was not long, but as the extent of the workings increased and the haulage became longer, it gradually became more difficult to get sufficient coal to the shaft bottom to charge the coke ovens in the usual working time. At present there are four haulage landings in the mine, and the aggregate length of the haulage, with its branches, is 11,000 ft., the longest single haul being 6,100 ft. As the haulage was extended, it became necessary to haul more wagons at each trip to maintain the output; the number of wagons per trip was limited, however, by the distance between the shaft and the switch from the main track. In order to provide a larger landing, to save the time occupied in switching in and out of the shaft bottom, and for other reasons, it was decided to do away with the old arrangement altogether. The plan was to remove the haulage engines from the surface to the mine, to excavate an entirely new shaft bottom, and to so arrange it that the movements of the trips would be as direct as possible. Accordingly, the plans were decided upon, work was started in March, 1898, and the shaft bottom was first used in January, 1899.

Arrangement of Heading.—Beginning at the center of the shaft, a double track landing was driven in a direction perpendicular to the center line of the guides of the shaft for 447 ft. The center line of the heading then curves to the right with a radius of 153.6 ft., for a distance of 244 ft., the two tracks coming together at Station 5 + 40. The forward tangent to this curve makes an angle of 30° 18′ with the main dip heading, which it joins with a curve to the left of 340 ft. radius for 165 ft., the point of tangent being about 900 ft. below the old shaft bottom landing. The alinement of the haulage road is clearly shown in Fig. 1. About 150 ft. of the old manway is utilized as a portion of the new heading, which was planned to weaken the existing pillars as little as possible, consistent with a good location and easy curves.

Grades.—The profile of the new haulage heading is shown in Fig. 2. The grade on the main dip heading, below Station 37, at which point the new heading turns to the right, is + 2.85%, and the same grade is continued for 100 ft. Then 500 ft. of + 5.15% grade and 100 ft. of + 1.90% extend to the knuckle, from which point a descending grade of 1% goes to the shaft. Upon this grade, when the pit wagons are in ordinarily good condition, they require but very little pushing to keep in motion. The loaded wagons knock the empty ones off the cages, and, in running down the 4.89% grade back of the shaft, the empties acquire enough momentum to carry them past the points of the switch on the empty track. They then run back and down the 1.5% grade, past the shaft, to a point in front of it, where they are attached to an endless rope and hauled up the incline to the knuckle. Beyond this they run by gravity, pulling the rope after them, for about 1,200 ft., where the tail rope is attached and the trip is pulled to its landing.

Arrangement of Tracks.—The detailed plans of

the shaft bottom, Fig. 3, show clearly the arrangement of tracks, and their elevations at various points. The loaded track was placed upon the left side of the landing looking toward the shaft, on account of the air compartment of the shaft, which is the main intake of the mine. The two tracks are parallel to within 41 ft. of the shaft, where the empty track curves around the shaft and where a switch in the loaded track leads to the right cageway. Back of the shaft the tracks curve to the right, using the old heading. The sections of the landing show clearly the positions of tracks and the clearances around the wagons. At the knuckle, the two tracks are on the same level, but going toward the shaft the loaded track descends on a 1%, and the empty track on a 1.98% grade, so an 18-in. retaining wall was built between them to hold the material under the loaded track. The section at 0+75, in front of the shaft, shows this wall at its highest point. The top of the wall is covered with a coping of timbers 6 × 15 ins. to protect the rope. The cager walks along the top of the wall, beside the wagons, when caging, having ample room in which to work. On the empty track, room was allowed on each side of the wagons for walking. Back of the shaft, as shown by the section, there is ample room on both sides of the wagons, as the full width of the old heading was utilized, the side walls being built against the coal.

In front of the shaft, the grade of the bottom of the beams, or top of the wall, is 7 ft. above the top of rail of the loaded track. This same grade was carried back of the shaft, regardless of the

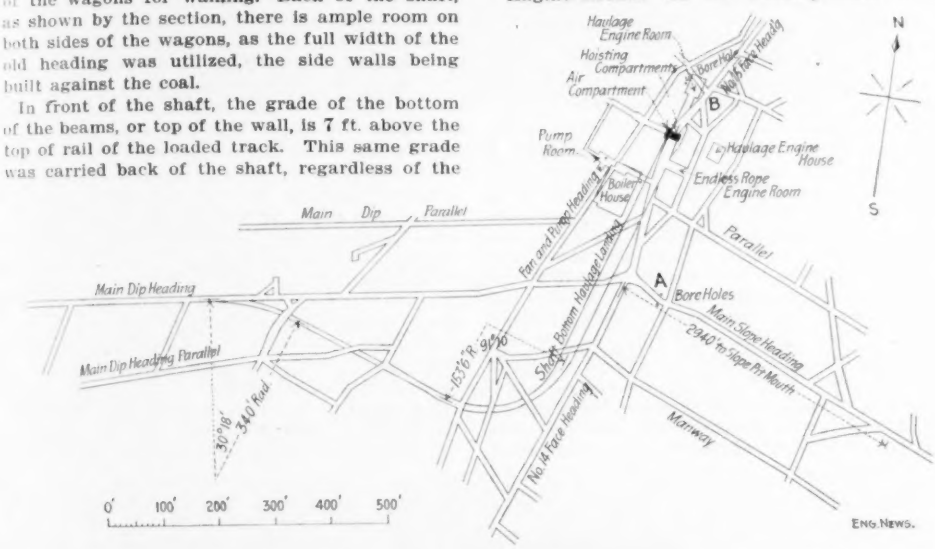

FIG. 1.—PLAN OF SHAFT AND HEADING AT THE MAMMOTH COAL MINE.
H. C. Frick Coal Co.

track levels, on account of the position of the pulling rope, which, when the drum is full, is 4 ins. below the bottom of the beams.

Arrangement of Posts and Beams at Bottom of Shaft.—In the old shaft bottom landing, the timbering extended up to the shaft on about the same elevation above the rail as it was elsewhere in the landing, and the first set of timbers in the shaft was set upon timber bents. While this arrangement of timbers is common in the older shafts of the region, it is difficult with it to take rails of the standard length of 30 ft. down the shaft, on account of the restricted area of the cageways and the small height at the bottom. As the old timbering was removed in the execution of this work, the arrangement shown in the elevation of the shaft in Fig. 3 was put in. The third beam in front of the shaft is 7 ft. above the rail, and from that the roof is sloped to the beam directly under the shaft timbering, which is 12 ft. above the rail. With the arrangement of the roof, a 30-ft. rail can be easily taken down the shaft.

On account of the air compartment at one side of the shaft, it was advisable that the empty track be brought as close to the cageways as it might be to avoid any unnecessary widening of the opening already there, and to avoid as much cutting of the material around the shaft as possible. To accomplish this it was decided to support the shaft timbering on steel Z-bar columns. The details of the columns are shown in Fig. 4. The columns were calculated for a load equal to the total weight of the timbering of the shaft, assuming that no hitch timbers had been used to distribute some of the weight upon the rock surrounding the shaft, and an ample margin was allowed on account of any possible corrosion of the steel. On account of the double thickness of timbers between the air and cageways, a steel plate was placed on top of the I-beams between the posts.

As there was no need of having the back of the shaft the same height as the front, a beam was placed between the posts 7 ft. above the rail, and a brick wall was built between it and the beam between the tops of the columns. Above the empty track the material was removed to a height sufficient to bring the bottom of the beams on the same grade line as the rest of the beams in the roof, and the beams were riveted to an I-beam between the posts at one end, and rest upon the wall at the other. The spaces between the columns, above the beams of the empty track, were closed by brick walls resting upon steel plates on top of I-beams. On the loaded track side, the wall was built closely against the airway timbering, but, as it could not be extended across the airway without materially reducing its area, a 13-in. brick wall was built between the columns to seal the airway from the cageways.

Engine-Rooms.—As the heading back of the shaft turned to the right, it was possible to place the haulage engine-room directly back of the shaft, so that the pull from the engines to the end of the landing would be straight, and the incoming trips would be visible to the engineer. The center line of the pulling rope drum was placed in the center of the shaft produced, and 86 ft. from the center of the guides of the shaft. The pulling rope passes between the guides and a sheave wheel is placed just back of the cageways to keep it in line. The lead from this sheave to the drum is about 80 ft., which allows the rope to coil properly upon the drum. From the position of the drum the engine-room was laid out, clearance being allowed all around the engines so that any part of them can be removed and replaced. The engine-room is built in the same way as the shaft bottom, with stone side walls and I-beams in the roof. The back of the room is closed by a brick wall, in which is an iron door, 24 ins. square, for ventilation. This door opens into the heading back of the engine-room, which connects directly with the main airway. The entrance to the engine-room is through a brick arch, opening from the side wall of the shaft bottom. Ample room is allowed for the passage of the ropes, and the floor of the arch is covered with 3-in. tile brick, sloping from the general level of the main heading to the floor of the engine-room.

The endless rope engine-room, in front of the shaft, is similar in its general design to the larger one. Very little excavation was required for it, as an old heading was used for the room, after being widened and straightened for the walls.

Character of Work.—The walls of the engine-rooms and shaft bottom landing are of rubble masonry, laid in 1 to 2 Louisville cement mortar. The smallest stone allowed under the specifications were 6 × 12 × 12 ins., and one-fourth of all the stones in the wall are headers. Joints were not to exceed ½-in. in thickness. The material was furnished by the company, in acordance with its usual custom, and delivered to the contractor at the place of work. The steel beams were furnished and put in place by the company, as was also the 2-in. oak lagging covering the beams.

Construction.—The shaft bottom was designed with a view to its being built with as little interference as possible with the daily operation of the plant. Until the shaft bottom was practically completed, and it was necessary to move the haulage engines from the surface into the mine, not a single day's run was lost. The work was begun at the bottom of the shaft, and the walls were built at night from there to a point where the tracks of the old landing crossed the line of the wall. At night and during "lay-off" days, when the mine was not in operation, the foundations for the columns were built, the columns erected, and the framing around the bottom of the shaft completed. There was no trouble in building the walls back of the shaft and the engine-rooms, because they did not interfere with the operation of the shaft bottom. While this work was being done, the excavation of the new heading was begun and carried through to the slope as a narrow heading, to avoid weakening the pillar, and then it was widened in sections as the work progressed. These sections were usually about 12 ft. long, and as soon as the walls had been built the beams were placed in position. While the masons were working at one section, another one was being prepared for them, and in this way the work was executed without any undue weakening of the supports for the shaft. When the excavation had been well started between the shaft and the main heading, work was begun in the same manner between the main heading and the curve, and was pushed in the same way. No walls were built in the immediate vicinity of the crossing of the main heading until the shaft bottom was nearing completion, when the walls were built along both sides of the main heading up to No. 15 face heading, and the track connection was made with the main track in use. When the operation of the shaft was shut down, the wall was built along the lower side of the landing across the main heading, and the beams were placed in position on this section.

Before the plans for the landing were made, levels were taken to obtain a profile of the roof above the timbers in the shaft bottom. These showed that the slates above the coal had fallen to a height of from 4 to 6 ft. in some places, as illustrated in Fig. 2. As this was the result of years, it was not anticipated that there would be much cutting of the roof during the interval between the excavation of the heading and placing the beams in position, when the space between the lagging and the roof would be packed with ashes. When the excavation was made, however, it was found that the roof came down almost immediately, and between the shaft bottom and the main heading, an average of about 6 ft. of slate was taken down over the whole width of the landing. On the other side of the main heading not so much trouble with the roof was experienced.

Arrangement of Ropes.—When the work was being completed the sheaves for the ropes were put in position in the new heading, the tail rope being supported by small sheaves on posts at the side of the heading, while the pulling rope is supported by rollers in the center of the track, and by 24-in. cast-iron sheaves at the side of the track (Fig. 5) around curves.

From the knuckle, the pulling rope goes to the bull wheel near the shaft, and thence between the guides to the drum. On account of the cager, the rope is overhead at the shaft, and it is taken under another sheave to bring it near the top of the wall. A line of rollers on top of the wall, and one by the side of the empty track prevent the rope's running on the bottom, both when coming in and going out. The tail rope goes from the drum to a sheave back of the shaft, and thence through a 4-in. pipe, supported by angles riveted to the posts, and along the line of sheaves hung

from the bottom of the beams. The sheaves are spaced about 24 ft. apart, and the hangers about 8 ft. apart.

The endless rope for the empties, after leaving the tightener back of the engine, passes around the bull wheel in the center of the track, in front of the engine-room (Fig. 6), up the center of the track to the bull wheel at the knuckle; from that to the line of small sheaves suspended from the beams, and around the overhead bull wheel in front of the engine-room to the drum.

Steam Lines.—The steam for the haulage engine comes from the boiler-house on the surface through a 14-in. bore hole drilled from the surface of the ground near the shaft to a point in the coal near the side of the engine-room (Fig. 3). The hole was cased with oil-well casing, 10 ins. internal diameter, and, in the center of this, the 6-in. steam pipe for the engine was placed. The exhaust pipes were connected with the bottom of the casing, and the exhaust steam reaches the surface through the annular space surrounding the steam pipe. The steam for the endless rope engine is taken from the pump-room in the heading parallel to the shaft bottom.

Operation.—The operation of caging has already been described, the empty wagons running from the shaft, switching, and running to a point near the endless rope engine-room by gravity. When the shaft bottom was designed, it was intended that the endless rope should run very slowly all the time, so that, as the empties came from the shaft, they could be coupled together and pulled up the grades by a grip attached to the rope and the first wagon. When the front of the trip would reach the knuckle, the tail rope would be attached to the first wagon, and the trip hauled into the mine. When the landing was completed, however, it was found advisable, on account of the grades, to cut off the tail rope at the first landing in the mine, about 1,200 ft. from the end of the shaft bottom, and to allow the empty wagons on the return trip to descend to that point by gravity. This necessitated a change in the method of working the endless haulage, and accordingly the empties are pulled up as they accumulate from the shaft, and, when the trip is ready, the grip is attached to the last wagon, and the whole trip, pulling the main rope after it, is pushed over the knuckle, when the grip is removed and the wagons run by gravity into the mine.

The grip in use is called the "Lemon" grip, and is manufactured, under patents, by the Robinson Machine Co., of Monongahela, Pa. Two jaws, lined with soft iron, the upper one of which can be forced down upon the lower one by means of a screw, are connected to a hook which is attached to the draw-bar of the wagon. The grip is a very simple and effective contrivance, one of them being capable of pulling 25 wagons, weighing 1,800 lbs. each, up the 2% grade to the knuckle.

In the construction of the shaft bottom landing, 1,140 cu. yds. of rubble masonry were built, 79,000 bricks laid, and 189,000 lbs. of steel used for beams and posts.

The plans for the shaft bottom were prepared by the writer, under the direction of Mr. J. P. K. Miller, Chief Engineer.

LAYING A 6-IN. WATER MAIN ACROSS HAVANA HARBOR.

By Howard Egleston, C. E.

During the recent blockade of Havana, the water supply provided for the large number of Spanish troops stationed in Morro Castle and Cabanas proved entirely inadequate, and the Spanish engineer officer who proposed to carry a pipe across the bay to supply the troops with water from Havana mains was looked on as a savior of the army. Under his direction, a rope, very slack twisted, of thin 2-in. wrought-iron pipes was made up and successfully laid. Of these only one is now in use. What became of the others is a mystery. This supply was only for the troops, and no account was taken of the necessities of a large number of people living in a village along the water front, known as Casa Blanca. The American engineers, believing that these people needed water as well as the soldiers stationed in Cabanas and Morro, decided to lay a main across the bay of sufficient capacity to give a plentiful supply of water, not only to the fortifications, but also to the town of Casa Blanca. To this end bids were asked for laying a 6-in. cast-iron water pipe from the foot of Empedrador St., in Havana, to the shore immediately in front of Cabanas. No bids were made prior to the advertised time of opening, but several were put in at a later date. The wide variation in these bids, indicating small knowledge of the nature of the work to be done.

The firm of which I am a member having made the lowest bid, and as my plan for doing the work met with the approval of Gen. Wm. Ludlow, Commanding the Department of Havana, and Col. Wm. M. Black, Chief Engineer, Department of Havana, I was requested to take charge of the work for the engineer department, it being thought safer to have the work done by the Government than by any private contractor, the possibilities of accident by collision being thought to be less. The plan determined on provided for the joining of the pipes on a barge which was drawn across the bay, the water pipes being "payed out" by means of a "skid" reaching to the bottom of the bay. An old scow belonging to the Engineer Department was selected and rigged with an inclined platform and boom, as shown in the accompanying engraving. A "skid" was built of 3 × 8-in. yellow pine timbers separated by blocks 5 × 8½ ins. × 6 ft., ½-in. bolts passing through and making a frame, as shown in the illustration. This "skid" was made in two sections of 60 ft., and one of 30 ft., making in all over 150 ft. The ends of each one of these sections were so fashioned as to make "rule joints" when they were put together. An extra "skid," 98 ft. long, was built and fastened on the inclined platform to act as a continuation of the portion of the skid that was suspended in the water. On this, all the pipe was leaded together before being launched into the water. At the start, one of the 60-ft. lengths was placed on top of this stationary skid and pushed out behind the scow until it touched the floor. On this the pipe was joined and launched out by means of small wooden carriages, until the end of the pipe line was carried well ashore and made fast to a heavy dock timber we had uncovered in digging the trench for the pipe. Once the end was made fast, the work of laying the pipe went steadily on, the skid being pushed out as the bottom of the bay fell away, and one length of the skid after another was joined on till the entire 150 ft. were overboard, and suspended by six chains from the scow and a launch which we towed astern. In order to make provision for the safety of the pipe, in case of a storm, which I knew might break on us at any time within very short notice, all these chains were cut long enough to reach the deepest part of the harbor (58 ft.), and my plan was, in case we were caught by a storm, to plug the end of the pipe and lower it and the skid to the bottom, place buoys on the chains and take the scow and launch to a place of safety. The edge of the hurricane which caused sc much damage in Puerto Rico did reach us, and this plan was in part carried out, though as we were well across the harbor and in comparatively shallow water (only about 24 ft. at the end of the pipe), I did not lower the last section of the skid, but left it hanging free at the end of the launch. After the storm was over, everything was found in good order and the work proceeded without further delay.

In order to lower this skid, as the depth of water increased, the chains supporting it were led over iron sheaves fastened in beams that were lashed on deck crosswise of the boat, and which projected over the sides sufficiently to give clearance in hoisting and lowering the skid. One of these timbers was in the stern, one in the bow, and one amidship. A tackle was rigged on each of these timbers so that the skid might be easily raised or lowered; similar chains with tackle were rigged on the boom, which projected from the stern of the scow. The chains were marked every 5 ft. with a tag and a scale was painted on the beams, so that the depth of the skid at any point of attachment might be readily seen. A scale of proportionate depths for each chain was calculated and the chains were lowered away accordingly as the work reached deeper water and raised as we ascended the slope after crossing the channel.

The original plan contemplated a double row of anchors placed 200 ft each side of the line of pipe and 125 ft. apart; but in placing them, they were spaced too far apart and only twelve were dropped in place. This error added greatly to the difficulty of the work, as we could not easily hold the scow steady when moving forward, and were obliged frequently to stop and make new arrangements of our hawsers, which would not have been necessary had the anchors been placed according to the plan. I did not try to correct the arrangement of these anchors because the steamer used for this work was in such poor order as to be unable to handle the anchors as desired. The anchors used were pairs of railway car wheels on axles, and proved very satisfactory, only one of them pulling out of position.

The operation of laying the pipe was as follows: The portion of the skid on the inclined platform was filled up with pieces of pipe, eight being joined up at a time. These eight were calked together; then these were joined on to the end of the pipe that projected out of the water, and held firmly in place by means of a tackle, and while so held, a lead joint was made. This plan was found to be necessary on account of the constant motion of the boat, which made it impossible to join a piece at a time to the main line of pipe without putting on a clamp each time. When the final joint had been made, as described above, men were stationed at the tackle attached to the various hawsers that served as guy ropes and the balance of the crew was sent to the windlass to haul in on the two forward hawsers, thus hauling the scow forward and paying out the pipe from the skid onto the bottom of the bay. When the last piece was within ten feet or so of the water, the work at the windless was stopped, the

FIG. 1.—BARGE FITTED FOR LAYING 6-IN. WATER MAIN ACROSS HAVANA HARBOR.
Gen. Wm. Ludlow, M. Am. Soc. C. E., Commanding Department of Havana.
Howard Egleston, Engineer in Charge of Work.

skid filled again, calked, joined, and again the scow was hauled forward. All this time a diver was kept in the water to see that everything was running smoothly under water. On approaching the shore, the skid was hauled on board, the two first sections being drawn by tackle from under the tube, leaving only the 30-ft. section in the water. On this the work of laying was continued to the shore.

The flexible joints used proved to be exceeding

FIG. 2.—VIEW OF HAVANA HARBOR, LOOKING TOWARD CASA BLANCA, SHOWING BARGE AT WORK LAYING WATER MAIN.

ly strong, and held against all strains put upon them, but they were not intended for such work as they were put to, and the constant working of the joints, due to the incessant motion of the boat, wore the lead packing to such an extent that every joint leaked slightly and needed recalking to make them tight. This was done so far as possible, but in the channel the mud into which the pipe had sunk was so deep that it was impossible to reach the joints.

Altogether 114 lengths of pipe were used, making the entire length of the pipe line 1,368 ft. Of this number, 76 lengths were of flexible joints; the balance, the ordinary stiff joints.

The special merit of the plan adopted consists in the freedom from obstruction of the harbor; during the entire time while the work was in progress, there was no day on which there was any impediment to free navigation of the harbor. The work was done at the narrowest part of the entrance to the harbor, and vessels of all kinds were constantly passing in and out, yet none of them were ever delayed. The port was ordered closed after 6 p. m., one night when I tried to carry on the work after dark, but this was abandoned on account of the greater risk of accident, and the freedom of the port was not again interfered with in any manner. Great difficulty was found to keep divers in the water on account of the great number of sharks in the harbor; one or more were caught every day by the fishermen within sight of our scow; some of them exceeding 15 ft. in length. By extra pay, this difficulty was overcome and a constant watch kept on the work below water.

The bottom of the harbor falls away very rapidly on the Casa Blanca side, the channel running close in until the greatest depth, 58 ft., is reached. This holds very constantly for 800 to 900 ft., until the other side of the channel is reached, when the depth lessens rapidly till 24 ft. is reached, and from there to the Havana shore, between 300 and 400 ft., the water shoals to 4 ft. at low water.

RECENT EXPERIENCE IN RAIL BONDING FOR ELECTRIC RAILWAYS.*

By Harold P. Brown.†

During the past year several cities have discovered electrolytic troubles in their systems of underground piping, and in most cases have promptly antagonized the electric railway interests instead of joining them to secure the best results for all concerned with the least possible delay and expense. This is unfortunate, since deadlocks and law suits, like those at Peoria, Ill., are interminable and vexatious. This Peoria case, by the way, is to be carried to the U. S. Supreme Court, to establish whether or not electrical railways can be made responsible for electrolytic injury of water pipes.

As a class, electric railway engineers have learned that poor bonding may double the cost of their power and seriously injure the water pipes, and that ideal conditions are realized when the bonding has a permanent conductivity equal to that of the rail. Many of them have found from experience that a copper wire, riveted into the rail, is bad at the start, and grows worse as time passes. About two years ago this type of bond was discredited by the advanced men, and in their place short, flexible copper bonds were used, generally placed under the angle plate. These were bands of thin copper strips, or cables of small wires, on the ends of which projecting lugs were cast or brazed to form terminals. Holes of ⅝-in. to ⅞-in. diameter were bored into the web of the rail, into which these terminals were expanded by screw pressure or by driving a tapered steel plug through a hole in the lug. The former method gives the better mechanical results, as was proved by tests made by Mr. W. D. Wright, E. E., of the Union Railroad, Providence, R. I. After setting several of these types of bonds in holes ⅞-in. in diameter through a steel plate ½-in. thick, a horizontal lever 18 ins. long was attached to each, and weight gradually placed upon the end of lever until the friction of the terminal was overcome. The screw-compressed terminal turned with an average weight of 143 lbs., while the terminals with taper steel plugs required but 65 lbs.

At first this seemed a decided advantage in favor of screw compression bonds, but experience has proved the opposite, for this bond was set so tightly that all the motion of the rail ends was concentrated upon the copper copper strips. The result is the crystallization and parting of the copper strips by the repeated bendings. Thousands of these bonds have already given out during the first year's use, and require replacing. Since they are covered by the angle plate, and the bands give out one by one, their bad condition may escape notice for a long time, while the breaking of a bond made of a single wire is at once evident. The other bonds, having a poor mechanical joint, do not put so severe a mechanical strain on the copper wires, and therefore last longer. But the looseness that helps them mechanically allows moisture to penetrate between the copper terminal and the sides of the hole in the rail, thus making a coating of rust of high resistance, which cuts down the carrying capacity of the bond.

A promising copper bond has recently been designed, in which the conductor is a solid piece of copper ⅛-in. thick, 3 ins. long, and 1¾ to 2 ins. or more high. It has a projecting contact cup pressed on each end, and is placed under the angle plate so that one cup touches the web of one rail, and the other cup the end of the adjoining rail. The bond is held against the rails by a strong steel spring placed in each cup and compressed by the tightening of the angle plate. Each spring rests on a disk of sheet steel so that it cannot cut into the copper, and gives a pressure of about 1,000 lbs. per sq. in. This bond is tightened by setting up the track nuts.

I regret to state that the electrical condition of the water pipes at Dayton, Ohio, is still unsatisfactory, and the installation of cast-weld joints on some of the lines has had no beneficial effect. In Evansville, Ind., there has been serious damage done to the water pipes. The railways there plan to replace any missing bonds with a No. 0 wire, which is little larger than a shoestring. I am informed that they wish to make frequent connections between rails and water pipes in all parts of the city, thus offering every inducement for the current to return on the pipes instead of on the rails. This, of course, should never be permitted.

In Franklin, Ohio, where an electric line has been in operation about two years, lead service pipes have been renewed four times in the past year in some places. The pipes are said to be 28 volts positive to the rails at several points. Any one could obtain free electric power and light by putting motors or lamps in circuit between the water pipe and the rail.

In Indianapolis, with a maximum current of 2,800 amperes from the power house, the water pipes are carrying 1,400 amperes with a maximum positive pressure of 8.2 volts. This means more than 150 HP. at work to injure the pipes. These measurements were made since the general installation of the cast-weld joints, which are advertised as good conductors. Previously, under similar conditions, the highest reading of positive pressure was 6.8 volts. This shows that the cast-weld joint is even a worse conductor than the small copper bonds formerly used on the rails. This is not the whole story, however, for, according to Mr. Brownell, who made the electrical tests, not only had the positive charge of the water pipes increased 20% since the adoption of the cast-weld, but the area in which the pipes were in dangerous condition had been doubled. The railways, I am told, put in these joints with the expectation that they would prove such good conductors that the water pipes would be relieved of their electrical load. But the conditions have been made much worse, and the railway has been sued for damages.

At Logansport, Ind., the ends of the railway return wires are carefully dropped into an open well. They might as well connect them to a hitching post. I do not know what bonds they use, but about half of their track is said to be without bonds. As a result, with only 200 amperes output from the power house, the water pipes are about 18 volts positive to the rails. From other cities comes the same story, with endless variations; poor bonds and injury to pipes.

In conclusion, I again urge the importance of thorough and frequent electrical inspections of the water pipes and friendly consultation with the railway managers when dangerous conditions are found to exist. And I again advise the insertion of lengths of iron-banded wooden pipes into the water mains at intervals, so as to make the mains of less conductivity than the rails. This, with good bonding, suitable and properly-balanced return wires from rails and water mains, and continued electrical tests, will prevent any serious trouble from electrolysis.

*Condensed from a paper presented at the Toronto meeting of the American Society of Municipal Improvements.

†120 Liberty St., New York city.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.*

Building Ignited by Electric Current.

George W. Miles built a store building in Lexington, S. C. In front of the building and projecting into the street was a frame work to hold up an awning. On the night of June 20, 1897, during a storm, the building caught fire and burned. Miles claimed that the telegraph company negligently allowed its wire in front of the store to become loose on one of the insulators attached to the telegraph pole and to sway and fall upon the frame attached to the front of the building so that the wire, on the night of the storm, conveyed a current or currents of electricity on and into the store building, causing it to ignite and burn down. In an action commenced against the telegraph company by Miles, the company disputed the facts to the extent of alleging that the building had caught fire first from lightning, and that the heat from the fire caused the defects in the line, and also that if the building did ignite from a current conveyed by the wire it was an act of God for which it was not liable. The company also alleged negligence on the part of Miles in allowing the frame work to extend into the street and too near the telegraph line. In Common Pleas Circuit Court of Lexington county there was verdict and judgment for plaintiff, from which the telegraph company appealed. The judgment has just been affirmed by the South Carolina Supreme Court, which ruled as follows:

A charge that the jury should determine whether the store caused the wire to break by reason of the fact that the store was on fire and heated the same, and caused it to break and become defective, or whether the wire, by reason of the defects complained of, caused the store to ignite, was not a charge on the facts.

A charge based on the theory that the company was entitled to a reasonable time, after notice of the falling of the wire, to repair or remove it, was properly refused, as having no application to the case.

A land owner cannot be guilty of negligence contributing to an injury caused by telegraph wires in front of his property because he encroached on the line of poles and wires with his building, so long as the building remained on his own land.

In an action against a telegraph company for damage to plaintiff's building caused by defect in the wires in the street in front of it, the court properly refused to charge that it was incumbent on plaintiff to exercise the prudence, diligence and care in the erection of his building as was imposed on defendant in the erection of its lines on the street.

Miles vs. Postal Tel. Cable Co., 33 S. E. Rep. (S. C.), 493.

Taking Dirt for Levees in Arkansas.

It is the policy of the state of Arkansas to recognize the right of land owners to compensation for property taken or damaged in making or repairing levees along the Mississippi River, and a levee board created by an act providing for such compensation cannot assert the right to take property without compensation on the ground that all property bordering on the river within the original territory of Louisiana is subject to a servitude for its use for levee purposes. Board of Levee Inspectors of Chicot County vs. Crittenden, 94 Fed. Rep. (U. S.), 613.

Liability for Creation of Nuisance.

A municipal corporation, though authorized by statute to construct sewers, has no right to so construct its system as to discharge sewage on the lands of an individual, or in such place that it flows on his lands, and pollutes a water course thereon, or otherwise creates a nuisance by which he suffers damage.

Carmichael et ux. vs. City of Texarkana, Ark., et al., 94 Fed. Rep. (U. S.), 561.

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The intelligent ostrich, when pursued by the hunters until escape seems hopeless, endeavors to hide from their sight by thrusting her head into any sand heap or layer of rubbish that she can find. New York has recently seen some very prominent gentlemen endeavoring to escape from the storm of public indignation which greeted the exposure of the attempted Ramapo steal, by pursuing tactics which betray their close relationship with the ostrich.

It is now gravely asserted by these gentlemen that the Ramapo Water Co. never hoped or expected to make any money out of its proposed water contract with New York city. They fully expected to lose money on that, and were only induced to engage in it as a piece of public benefaction. What they did expect to make money in, they now inform the public, was the development of electric energy from the water power of the Ramapo and its transmission to New York city. The sale of potable water to New York was merely "a side issue." Here comes one Mr. Wm. J. Jenks, "an electrical expert," according to his own confession, and declares that he has been "studying the electrical feature of the Ramapo scheme for several years," and that the company, "in addition to furnishing the metropolis with all of the electrical energy needed by her, also hopes to supply all the towns for miles about the Catskills and along the Hudson River near this city." From which it is evident that Mr. Jenks' "studies" have been conducted with the aid of a powerful magnifying glass.

The plain and well-known fact is that the whole flow from the water sheds where the company claims to possess some options, is too small to make its water power of any more than local importance. The story that the Ramapo contemplated water power development instead of water supply is a deliberate lie, concocted for the express purpose of quieting public indignation against the promoters of this scheme of highway robbery, and for the purpose of giving a color of plausibility to that other falsehood, that the company could not afford to furnish the water at the price which was set in the proposed contract.

The ostrich nature has revealed itself before in some of those prominently connected with the Ramapo scheme, as evidenced by a tendency to gobble up valuable franchises and other public property. We do not believe that this last ostrich act of these promoters will avail to save them from the just public indignation and contempt which they so richly deserve.

THE WORK OF ENGINEERS IN THE MILITARY GOVERNMENT OF HAVANA, CUBA.

As a chronicle of difficulties encountered and results accomplished, the improvement which has been brought about in the sanitary condition of the city of Havana, Cuba, by its present American rulers deserves thoughtful attention. We are led to make this statement by reading the report for the six months ending June 30, 1899, of General William Ludlow, M. Am. Soc. C. E., Commanding the Department of Havana, and Military Governor of the city of Havana, which has just been published, and an abstract of which we print elsewhere in this issue. The account which this report presents of the work which has been accomplished at the former Cuban capital, shows that it has been a notable one both in its extent and in its excellent character. To most of our readers it will also have particular interest from the fact that it has been performed by engineers. Both General Ludlow, the Military Governor of the city, and Maj. William M. Black, his chief engineer, are members of the Corps of Engineers, U. S. A., and both have won high reputations by their previous works. Because of their professional relationship, if for no other reason, engineers will be interested in studying the work of these officers in their new field of labor; but we believe that there are reasons of greater importance than this why their work will repay thoughtful scrutiny by every person who can appreciate energy and integrity in the performance of duty.

To enforce the point which we wish to make here it will be necessary to review briefly the work which has been accomplished at Havana. The problem which presented itself here when the American governors assumed control was a many-sided one, and it is important that we should get a right knowledge of it at the beginning.

The exigencies of war, as interpreted by Cuba's Spanish rulers, had, as our readers know, brought about a pretty complete destruction of all industrial activity in that island. As a consequence of this, the country surrounding Havana, and to a less degree the city itself, were in an impoverished condition when the Americans took control. This was not the worst, however, Unfortunately, the former Spanish government knew, or, at least, practiced, little or nothing of public sanitation, and for an indefinite period Havana had gone on accumulating filth and spreading the germs of disease until its very name was suggestive of infection. Added to these serious evils was the fact that a large population (the aggregate is given as over 20,000 persons) had to be rescued from starvation and nourished back to a condition of self-support. Besides these pressing needs, a civil government had to be established and a people of naturally jealous and excitable temperament, who had been rendered by years of oppression suspicious of all government, had to be convinced of the good faith of their new rulers, and trained to co-operate with them, instead of opposing them.

These were a few of the difficulties which beset the little band of American engineers when they took up their new responsibilities in Havana last January, and from even the above brief recital it can be seen that the task before them was enough to appal the most stout-hearted. Imperative demands that must be met at once on the one hand, lack of organization, tools, machines, and, in fact, everything necessary to accomplish work on the other. To hamper still further the new government in its labor, there were further experiences with the red tape and delays in the bureaus at Washington. A medical officer was not furnished by the Department until the middle of February; a regular quartermaster was not furnished until the end of March, and a commissary was not provided until a month later. The work of these departments had to be carried on, however, and the task of carrying it on fell upon the Military Governor and his assistants at Havana. A still more serious disadvantage was the method prescribed for obtaining funds for conducting the necessary sanitary and relief work. Monthly requisitions and minutely-detailed estimates had to be made in advance for each item of the work. This made it impracticable to plan for any work which could not be specified item for item a month before it was done. This prevented the exercise of any discretion or the spending of any money to meet unexpected contingencies in the work. The great delay and annoyance resulting from such a system in carrying out work of unknown character under the pressing and unusual demands of famine and pestilence are too evident to require comment. That the work was carried out as energetically and well as it has been is indeed wonderful under these conditions.

The abstract of General Ludlow's report, which we give elsewhere, shows the results accomplished in detail, and we need only summarize some of the more notable ones here. On Jan. 1, 1899, when the Americans took possession of Havana there were over 20,000 persons who were dependent upon public aid for food. In six months this number of destitute persons had been reduced to 6,000, and these were composed mostly of children and aged and infirm men and women. In 1898, owing to the unnatural conditions of the war and Spanish rule, the death rate of the city had climbed up to three times the normal for the preceding years since 1890. This rate of mortality has been reduced for the six months of 1899 to less than the normal. In the same period the government by martial law established by the Spaniards, has given place to a civil government by Cubans, under the general direction of a Military Governor. These are achievements of which General Ludlow and his aids may well be proud, and to emphasize this point we have stated them and the conditions under which they were accomplished at greater length, perhaps, than would otherwise be warranted in connection with the detailed report which is published in another column.

The evidences of material improvement at Havana which we have briefly recorded in the preceding paragraphs, constitute, however, only one feature of the work which has been done for that city. To say merely that starvation and disease have been checked, and that a stable government has been established, is, it seems to us, to tell only a part of the story. A little study will show that there has also been a notable mental and moral regeneration of the people, and a higher standard of living established throughout an entire community. Of more importance even than this, an example has been set of scrupulous fidelity in the discharge of trust which is especially worthy of public note at the present time.

In matters of sanitation at Havana the reform which has been wrought is not merely the cleaning of the city and the checking of disease, although this is in itself a great achievement. The fact which overshadows this is that a population entirely ignorant of sanitary rules has been taught to appreciate their value and to co-operate to the extent of its ability in seeing that they are observed. The mere cleansing of the superfices of the city from their accumulated filth was a task easily within the abilities of modern sanitary engineering. This work required only the knowledge of the proper methods to carry it out, and the money necessary to pay for the labor performed. Where the rank and file of an ignorant and dirty population has to be dealt with, however, permanent success in sanitation consists in something further than ability to clean up the dirt which the people make, and requires that they be taught not to make dirt. This is particularly true of a city like Havana, where the usual artificial aids and encouragements toward cleanliness which are afforded by sewers and modern plumbing and sanitary appliances are almost entirely lacking. It is worth especial notice, therefore, that General Ludlow and his aids have made distinct progress in this fundamental task.

We do not need to take up much space to inform engineers who have had any experience in the sanitation of a great city that it was not an

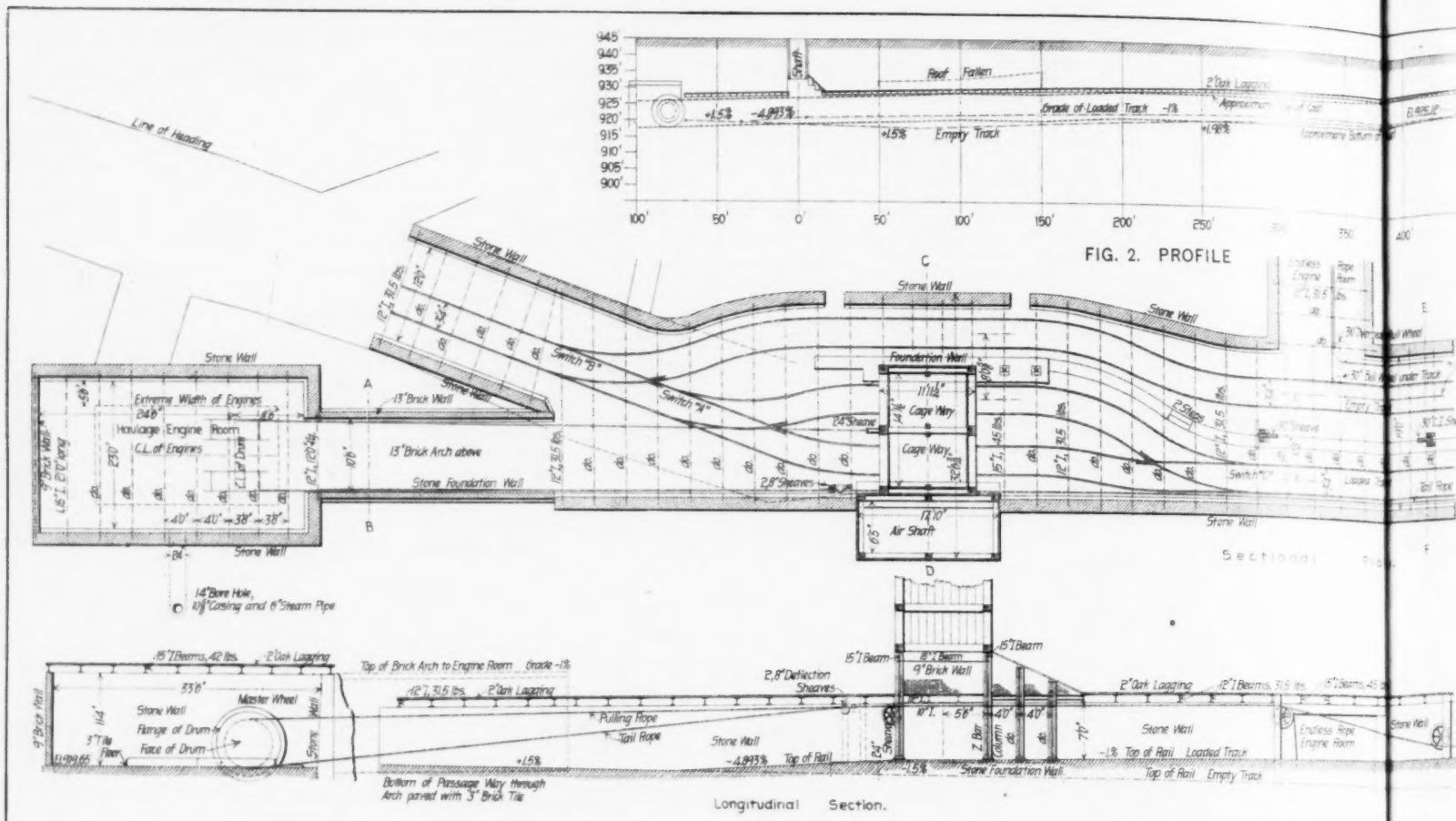
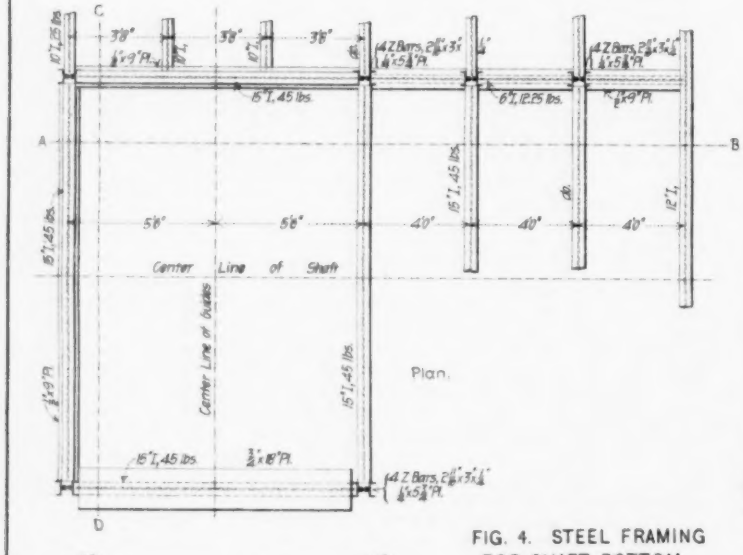
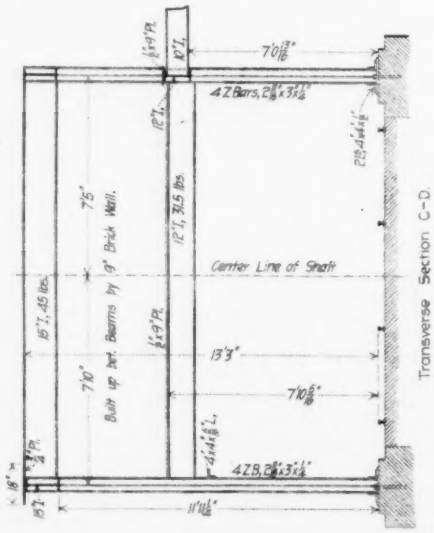


FIG. 2. PROFILE

FIG. 3. GENERAL DESIGN OF LANDING AT





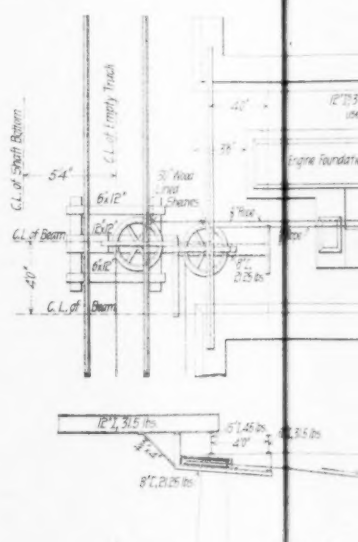
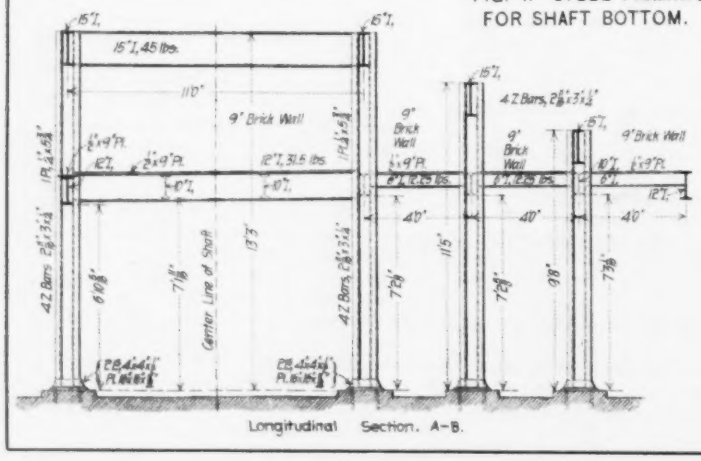


FIG. 4. STEEL FRAMING FOR SHAFT BOTTOM.



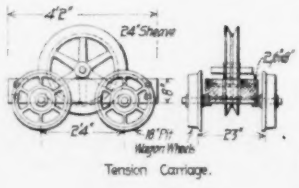
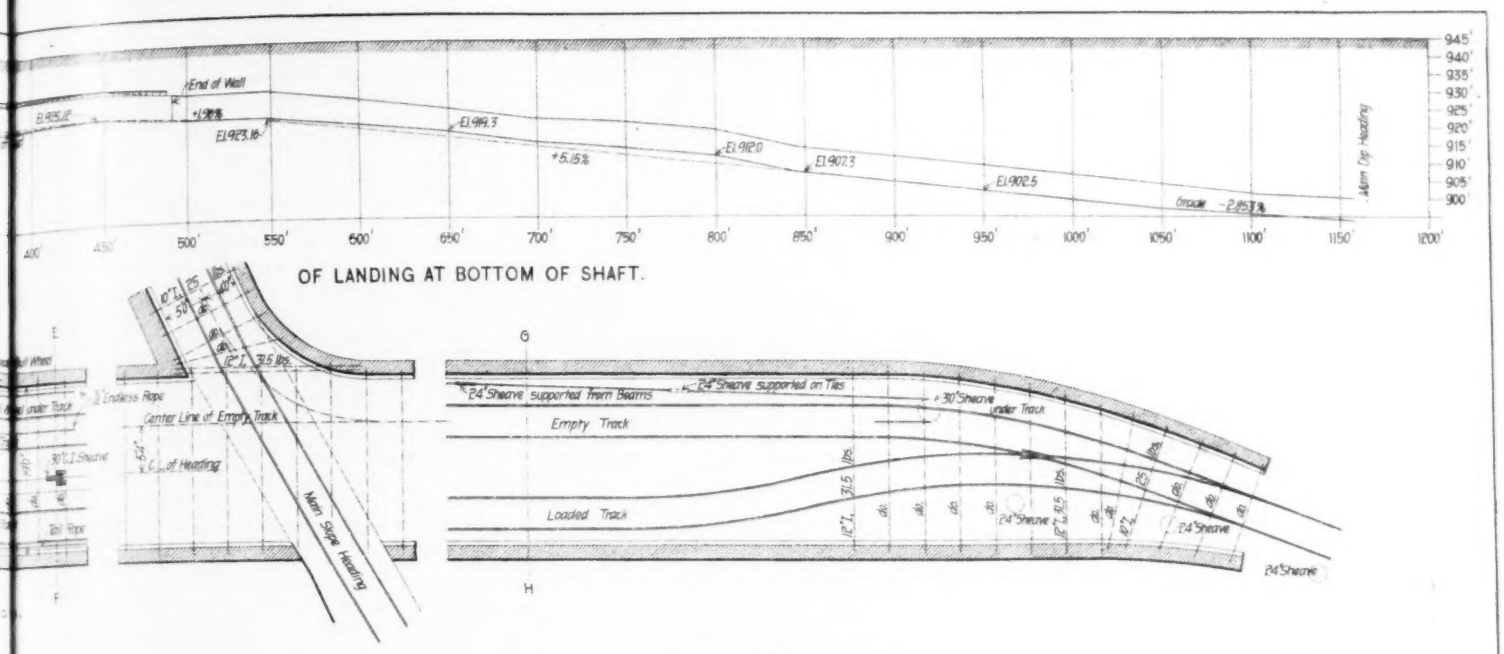
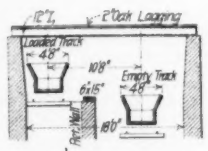
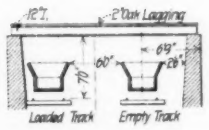


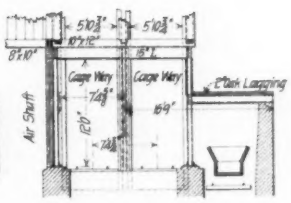
FIG. 6. ARRANGEMENT OF ROPES AND SHEAVES

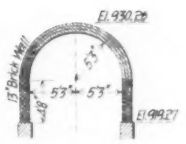


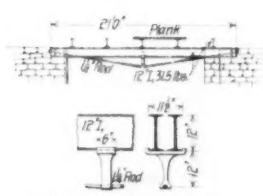
OF LANDING AT BOTTOM OF SHAFT.



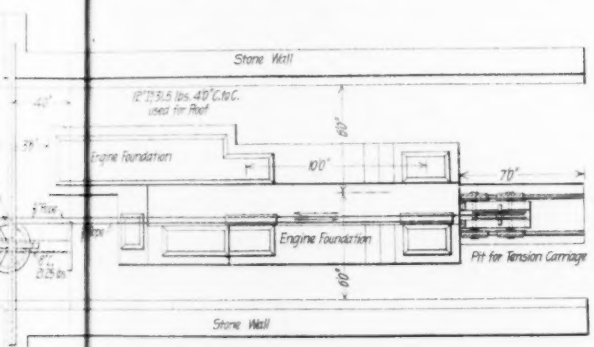




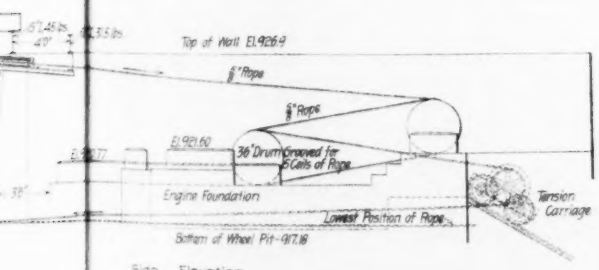




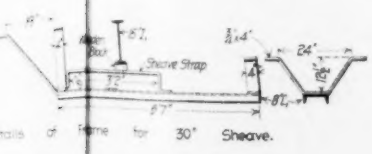
SIGN OF LANDING AT BOTTOM OF SHAFT.



Plan.



Side Elevation.



ails of Frame for 30" Sheave.

ROPES AND SHEAVES FOR ENDLESS ROPE DRIVE.

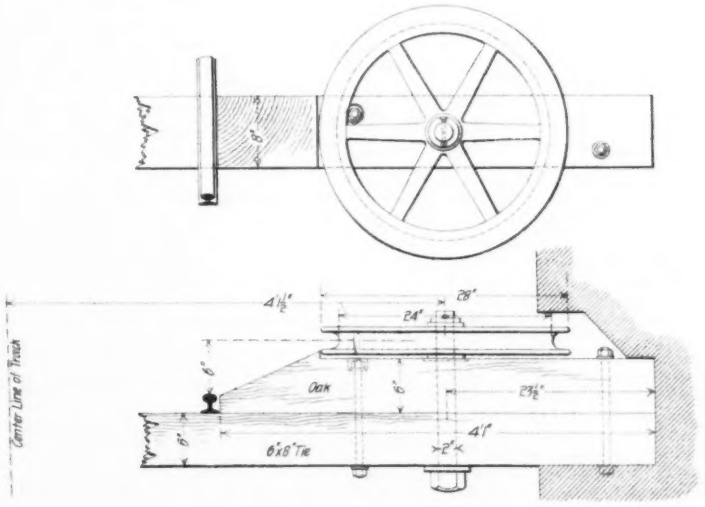


FIG. 5. ARRANGEMENT OF SHEAVES FOR HAULAGE.

BOTTOM HAULAGE LANDING AT THE SHAFT OF THE MAMMOTH COAL MINE, H. C. FRICK COKE CO.

J. P. K. Miller, Chief Engineer;
Howard N. Eavenson, Division Engineer.

CHAS. HART, LITH., 86 VESEY ST., N. Y.

easy task to teach these ignorant Cubans to observe sanitary and hygienic practices in disposing of their wastes. It is only by both persistence and insistence in demanding cleanliness that these classes of people, when they are surrounded by the constant example of clean living practiced in the best European and American cities, are made to keep themselves and their homes wholesome. The low-class Cubans in Havana, it must be remembered, have never had the incentive of good example on the part of their superiors. There was almost nothing in the previous life and habits of these people for General Ludlow and his aids to found their new teaching of cleanliness upon. It means much more, therefore, than it would in a well-kept American or European city, when they are able to say that the people of Havana have from a state of opposition come to co-operate in keeping the city clean, and can be depended upon for similar aid at all times "when informed of the necessity and shown what to do."

It is not claimed, of course, that more than a good beginning has been made at Havana, either in the work of teaching its people sanitary and hygienic laws or towards securing the permanent sanitation of the city, but it was this beginning amid the accumulated obstacles that was most difficult to make. The work so well begun must now be continued with thoroughness over a long period of time before the city can be made in any measure secure from the infectious diseases which have raged there in the past. It must also take on a permanent character which it has not so far assumed. The most obvious of the permanent improvements, which are required immediately, are the construction of a complete sewerage system and impermeable street pavements, the enforcing of sanitary plumbing in all buildings, and the thorough cleansing of the harbor from its filth. The best manner of carrying out these improvements is at present one upon which engineers who are familiar with the situation are not agreed, but no one questions their necessity or the need of immediate action.

Enough has been said, we think, to show that the work accomplished by General Ludlow and his heads of departments at Havana has been of an exceptionally high character. It has been accomplished, moreover, without the faintest shadow upon the integrity and faithfulness of any of these officers. This is not because there have not been opportunities to misuse and waste the public funds, or to favor private interests.

On the contrary, the average engineer, put under such circumstances as those which beset the Americans during the first six months in Havana, would have been very apt to "lose his head," first metaphorically and then literally. When emergencies are great, as they unquestionably were in Havana, the temptation is strong to neglect economy in attention to other imperative requirements. It takes a cool head, endowed with rare executive ability, to judge rightly in such cases and to know when extravagance is a virtue, and when it becomes a vice.

While we cannot pretend to have analyzed in detail the record of expenditures in the report, such figures as we have noted are surprisingly small in comparison with the work accomplished, and indicate a remarkable economy and efficiency in the prosecution of the works.

Again, every one familiar with affairs at Havana knows that there are corporate and individual interests there willing to pay handsomely for aid that it has been in the power of the American officials in control to bestow. These interests, however, are about the only complainants against the American rule.

The matter of franchises granted under the Spanish administration of the city and sought for since the Americans assumed control deserves, perhaps, a few words by itself. No one will dispute, we presume, that there is a field in Havana for private corporations to exercise public services under franchise rights from the city; or, that in time it will probably be advantageous to the city to grant some such privileges to responsible individuals and corporations, with such proper restrictions as are necessary to secure the public welfare. To contend, however, that the new administration was bound to assume a burden of responsible and irresponsible schemes bequeathed to it by the notoriously corrupt Spanish rule that preceded, without taking time to invesigate them, and without having studied the peculiar needs of the city, is absurd. These franchise rights were matters which could wait; and it was the part of wisdom that they should be made to wait, not only so that they could receive proper study, but because there was work which it was far more important to do immediately.

It is important to inquire to what the good results obtained by the American officers governing in Havana have been due. Their task, as we have seen, was one of great difficulty. Technical training and experience were requisite, but they were far from being the main factor in the success attained. Executive ability was more important, but even it was not the main factor. We believe the real secret of the success of such men as Ludlow and Black at Havana, and Wood at Santiago, lies in their earnest loyalty to duty, their energetic fidelity to their trust.

We need this quality in all our public officers; but it is an absolute requisite to success in the government of our new colonial possessions where most of the checks which exist at home on dishonesty and unfaithfulness are absent. We would lay especial stress, too, on the term energetic. It would have been an easy matter under the conditions prevailing at Havana for these American officers to have placed their work on the mere routine level of doing just what necessity compelled and nothing more. We do not know, for example, that Gen. Ludlow had any specific orders to stamp out yellow fever in Havana. In fact, there was a general public impression last winter that not much could be done for the sanitary reform of Havana until a sewer system was built; and building it last winter was impossible. There would have been no occasion for surprise, therefore, had the yellow fever continued to prevail as it had year after year under the old Spanish regime; and had the new American administration been made up of less energetic men, it very likely would have done so.

A month ago we called attention to the public lesson on the need of fidelity to trusts, which has been taught by the trial and conviction of Capt. Carter. We are glad now to emphasize the same lesson from the opposite point of view. The work of Gen. Ludlow in Havana is a glowing example of what an honest, fearless and capable public official can accomplish. Such deeds are more difficult and arduous than feats of valor or generalship in warfare on land or sea, and public recognition of them is seldom awarded. It is in such deeds, nevertheless, that the foundations of national greatness are more truly laid than in any war of conquest. It is only through the cultivation of such fidelity in our public officers that we can solve the difficult problems that vex us at home, as well as those that confront us beyond the seas.

LETTERS TO THE EDITOR.

Rates of Filtration of Sewage with Artificial Aeration —Correction.

Sir: In your issue of Sept. 28, in reporting the proceedings of the League of American Municipalities Convention, recently held in Syracuse, you quote me as saying that, by the use of artificially aerated filters, sewage can be purified to a drinking-water standard "at the rate of 125 gallons per sq. ft. per day, or 5,445,000 per acre."

I never made this statement. The rate of 125 gallons per sq. ft. is the rate at which sewage is passed through the working roughing-filter, which removes suspended impurities only. As these roughing-filters are used intermittently, in sets of three, the area required is three times that of the working bed, making the real rate, for clarification only, about 42 gallons per sq. ft.

For the removal of the dissolved impurities from the clarified sewage, the rate of filtration is still lower, only 25 gallons per sq. ft.; but these "aerator" beds are used continuously. When both suspended and dissolved impurities are to be removed, it is advisable to allow 64 sq. ft. of area for each thousand gallons to be treated, which makes the net rate of application about 680,000 gallons per acre.

It is true that a very thorough purification has frequently been obtained while the filters were working at a very much higher rate (over 3,000,000 gallons per acre per day); and this degree of efficiency could undoubtedly be maintained if the work were continually under expert control. But in designing such a system for the average municipality, a wide margin of safety must be allowed to offset insufficiency of knowledge and errors of judgment in operation. The rates named above have been fixed, after long experiment and experience, as adapted to yield a uniformly satisfactory effluent under control no more efficient than that of a reasonably conscientious and intelligent laborer. G. Everett Hill.

874 Broadway, New York, Oct. 4, 1899.

The Proper Valve Gear for High Economy in Marine Engine Practice.

Sir: The results of the trials of the freighter "Pennsylvania," published in your issue of Oct. 5, strikingly illustrates the barbarity of the practice of fitting multi-cylinder engines with single valves, and especially with single piston valves.

The steam credited to the main engines of the "Pennsylvania" on her first trial, May 28, is about 18% greater than is due to the high-pressure cylinder cut-off—which is not a bad showing as regards condensation and general leakage—but the loss of power due to improper valving and heat transmission and interchange is something like 47%. That is, allowing the experimentally determined initial loss of 18%, the power could, in a proper design, even with the same cylinder ratios and the same total expansion, be developed on 11,670 lbs. of water per hour as against the actual 17,252 lbs. found by trial, or about 9.72 lbs. of water per I. HP. hour or 1.1 lbs. of coal, a saving of full half a pound of coal per horse-power hour, or much more than would pay for the extra cost of additional valves and gear.

This is for 19 expansions, which the given cylinders are capable of by a reduction of the clearances that exist in the piston valves.

Quadruple expansion engines of the power of those in the "Pensylvania" (1,200 HP.) and carrying the same steam pressure (240 lbs.) can be designed on a guaranteed coal consumption of 1 lb. per I. HP. hour, for the same grade of coal used during the quoted trials, and this without filling the vessel with additional feed water heaters, economizers, etc.

It is useless to expect high pressure steam to make good the losses due to single valves, for not only is it impossible to secure continuous useful expansion with such gearing, but the heat interchange between the live and exhaust steam, separated only by a thin metallic plate like the valve wall, is enormous, and counteracts a large part of the economic advantage due to the higher pressures and greater expansion. Very truly,

C. M. Jones.

1514 N. Sixth St., Philadelphia, Pa., Oct. 6, 1899.

A Civil Engineer Abroad.

I.

Sir: The good ship "Nebraska," of the Allen and State line, which cleared from New York on May 4, last, sighted the Irish coast on the morning of the 15th inst., and the writer, with a few other passengers, were transferred at Moville to a steamer tender for Londonderry, situate about 18 miles up Lough Foyle from the sea. The attractions to the tourist at Londonderry are not numerous. The historic cathedral and the city wall are the chiefest. The latter is about a mile in circumference, and is very likely in better condition than when originally constructed as it has been well-cared for and much of it was rebuilt 30 or 40 years ago.

There is a general impression I believe that the incursion of American goods and American engineering into Europe is a thing of recent growth; but at Londonderry I found that the first bridge ever built across the river was the work of an American, Samuel Cox, of Cox & Co., of Boston, Mass. It was begun in 1789 and completed for foot passengers in 1790, and for vehicles in 1791. It was built of oak piles 14 to 18 ins. square, placed 16¼ ft. apart and strongly bound by string pieces. Its length was 1,068 ft., and width 40 ft., and it cost £16,284 6s. Upon removal the piles were found to be in first-class condition and sold readily. An iron bridge, of which a view is shown in Fig. 1, crosses the stream at the present time and replaces Cox's wooden structure, but is located further up the stream. The iron bridge is about 40 years old, and is a unique example of the use of eye-bars as compression members. The spans are about 120 ft., and the diagonals—eye-bars—from 5 to 8 ins. wide, according to their position in the truss, and 2 ins. thick. The eye-bars are in pairs and are tied to each other by small cylindrical separators. The top and bottom chords are built up of plates and angles, the bottom one making an excellent water trough. The construction at the piers—cast-iron ornamental grillage, etc., prevented one from seeing the truss ends or their bearings; but the sight of the gilded pin nuts was enough to make one forget the disappointment. The nuts, fully 4 ins. long, are on the outside of the trusses, and the gold paint makes them loom up like the brass buttons on a soldier's uniform.

From Londonderry I journeyed to Portrush and had my first experience in Irish railway travel. The exclusiveness of the compartment cars is all very well to talk about, but if you happen to be obliged to share your compartment with a man in the maudlin stage of intoxication, one

prefers a little less exclusiveness. The Irish freight cars are small affairs holding only 7 tons, and the switch engine in some cases is a stout horse. Nevertheless these cars are doubtless more economical by far for the traffic to be handled than our own 20-ton to 50-ton cars would be. The country is small, the hauls short and the quantities of freight to be handled in the interior are very small. The passenger stations are neat and the method of handling the passengers is good, although it would not suit the American public.

At Coleraine we changed cars, and in order to take the Portrush train I had to cross the tracks to the other platform. My valise reminded me of its presence when I had to lug it up and down the steps of an overhead crossing.

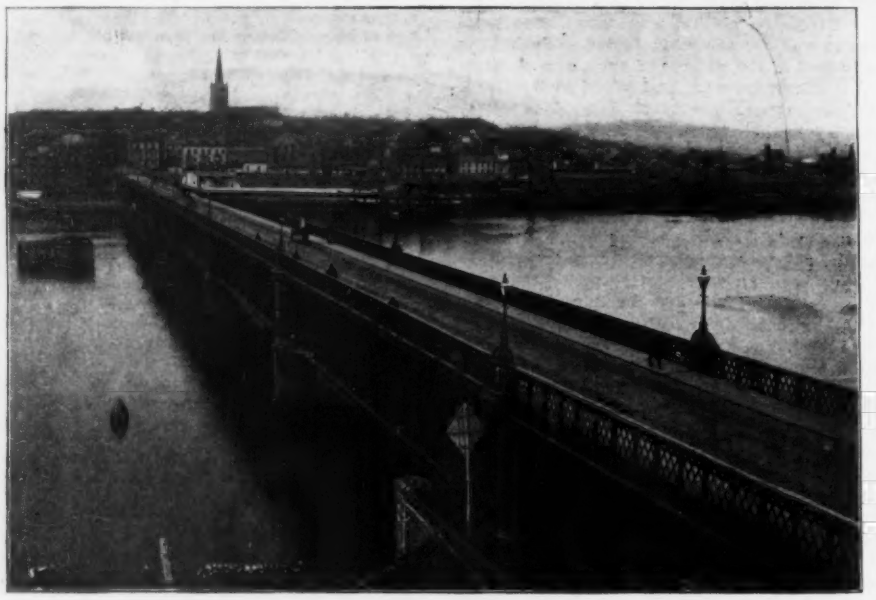


FIG. 1.—BRIDGE OVER THE RIVER FOYLE, AT LONDONDERRY, IRELAND.

At Portrush I took a "jaunting car" for the Giant's Causeway; a visit which no tourist should miss; but which has been too often described to make a repetition here worth while. The electric road to the causeway deserves mention, if for no other reason than that Americans are supplying the copper wire and poles and supervising the construction. The old electric road had an elevated rail, at one side of the track, for the current, but numerous accidents to cattle and the death of a bicycle rider who fell against it caused the company to change to the overhead wire.

A peculiar bonding of the sea-wall which runs along the roadside for some distance interested me, and a sketch of it is appended in Fig. 2. It would hardly be adopted I presume save in a country where labor is cheap.

From Portrush to Belfast the railway runs through a region of small farms and villages and everywhere the same evidence of careful cultivation is seen. The property or division fences are generally of earth 2 ft. high and 2 ft. thick, and capped with a hedge. Only a few places were seen where peat was dug, and all of the bogs that I saw were insignificant.

Belfast is the most enterprising city in Ireland, and has much in its general make-up to attract an American. For

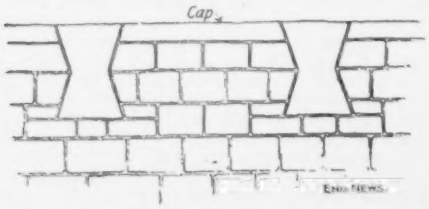


Fig. 2.—Face of Seawall Near Portrush, Ireland, Showing Bond Stones.

me it had one strong point of attraction, Harland & Wolf's shipyards, the largest in the world, where the "Oceanic"—the largest ship afloat was built. A visit to their office, however, convinced that nothing short of a letter of introduction would gain me admission into their yards and so I had to content myself with looking at the many ships as they lay on the stocks in all stages of incompletion, and at those at the sides of the docks which were having their machinery put in. I had a close look at the "Oceanic," but not even a letter of introduction could have gotten me aboard of her. From the "Oceanic" I went to the Alexandria Graving Dock—among the largest in the world—to which some alterations had to be made in the bottom corners before it could accommodate the "Oceanic." This dock is about 800 ft. long and 80 ft. wide at the top, and may be divided into three parts of 300, 200 and 300 ft. by two cofferdams in order to accommodate ships of different lengths. Fig. 3 is an excellent view of the dock taken from its head. To the left may be seen the 150-ton crane, mounted on piers and capable of swinging through more than 200° with a radius depending on the load from 30 ft. to 50 ft. At the time of my visit the crane was in use taking out the boilers and engines of the "China." The unfortunate vessel was also having timbers put through her, because the forward part of her bottom was so torn away that she could not rest upon it in the dock, and had to be supported by the timbers higher up. The sill of the dock is about 2 ft. below the blocks, and high water is about 23 ft. above them. The dock is emptied by centrifugal pumps of 60,000 gallons per minute capacity. This dock is the property of the municipality, and I was told that its success has convinced the officials that a second one is needed. The cap stones of the dock are held in line by square granite keys, a method in general use here for this class of work. I next visited the City Hall, where the assistant city engineer kindly gave me such information as he could regarding the local features, besides sending me to the engineer in charge of the reservoirs and filtering basins in Glenburn Park. Here a new engine house was under construction. The bricks used in the work—except ornamental tiles, &c.—had about 20 %-in. holes through them which acted as keys. The sand filtering beds are open, for the winters are so mild that heavy ice is rare. The sand washing is done in the beds and the polluted water is carried through the overflow in the center of the bed to the waste. The valve heads look like elongated fire plugs with an immense thermometer fastened to the side. They are convenient however, as the aforesaid thermometer is really an indicator on which the opening in inches of the valve can be read at a glance.

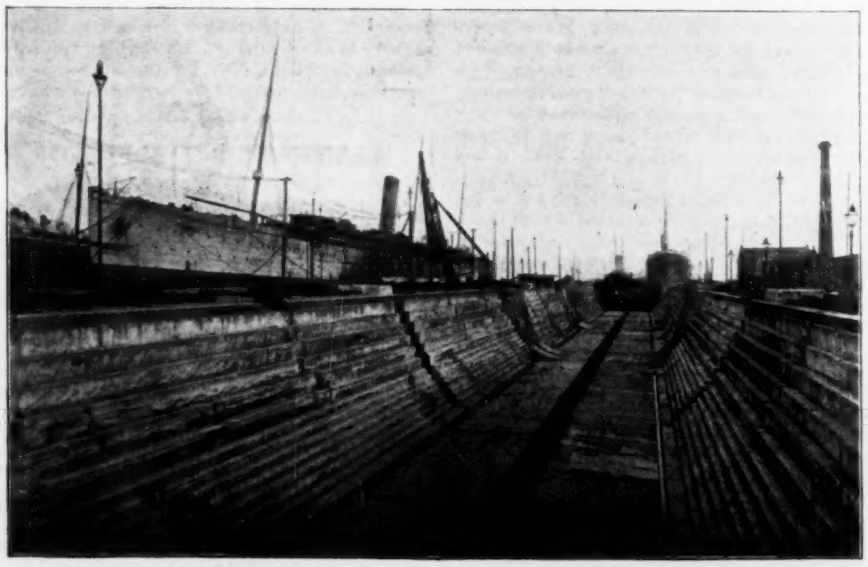


FIG. 3.—ALEXANDRA GRAVING DOCK, BELFAST, IRELAND.
(Steamer "Oceanic" on the left.)

An old railway bridge over the Lagan River in Belfast attracted my attention. It is a lattice girder structure of eight spans, each about 50 ft. The outside ends of the end trusses rest in suspenders, Fig. 4, to provide for expansion, and the other ends as well as all the ends of the other trusses rest on cast-iron octagonal piers. I also went down to the Queen's Bridge, Fig. 5, the oldest in Belfast. As the city grew it was found necessary to widen this bridge. This was done by sinking iron or steel box girders into the masonry of the piers—transversely of the bridge—so that the ends could carry the railings which are lattice girders in disguise, and take half the load of the footways. The whole width of the old bridge has been given up to vehicles. The additions to the bridge do not look like patchwork, as is too often the case under similar conditions, and the engineers deserve much praise for the artistic results. The Albert Bridge, Fig. 6, is a recent creation of three arches. Each arch consists of 11 cast-iron ribs divided into five segments. The cross-section of the ribs is about as shown in Fig. 7. This bridge has one feature open to criticism—the cast-iron facings of the arches are two thin. In one place several pieces are conspicuous by their absence, and a crack extends the full depth of the arch.

F. H. C.

New York, Aug. 28, 1899.

Notes and Queries.

Concerning the computation of sinking funds, referred to in a letter in our issue of Sept. 28, Mr. M. J. Butler, of Desoronto, Ont., calls our attention to a little book entitled "Compound Interest and Annuities," by Fedor Thoman, published by Crosby, Lockwood & Sons, of London, by which all actuarial problems may be promptly and accurately solved. The tables are logarithmic, and require the use of a 10-place table of logarithms to secure reasonable accuracy. The price of the book in the United States is $1.00.

THE ENGINEERING AND SANITARY RENOVATION OF HAVANA UNDER U. S. MILITARY GOVERNMENT.

The great work of regeneration which has been accomplished in the sanitary condition of the city of Havana, since its occupation by American troops in December, 1898, is fully described in the report just issued of Gen. William Ludlow, M. Am. Soc. C. E., Brigadier-General U. S. Volunteers, Commanding the Department of Havana. This report is dated June 30, 1899, and it covers the period to that time from the first American occupation of Havana in December, 1898. During this short period, however, the city has been transformed from a community beset with starvation and disease, and wallowing in filth, to one enjoying a stable government, and a condition of self-respecting cleanliness and health.

The last Spanish troops left Havana on Jan. 1, 1899; and although the American forces entered the city on Dec. 22, 1898, their only work up to Jan. 1 was to occupy and police the different districts of the city as they were successively evacuated by the departing Spanish soldiers. On Jan. 1, 1899, however, the American forces assumed full control of affairs. The physical condition of

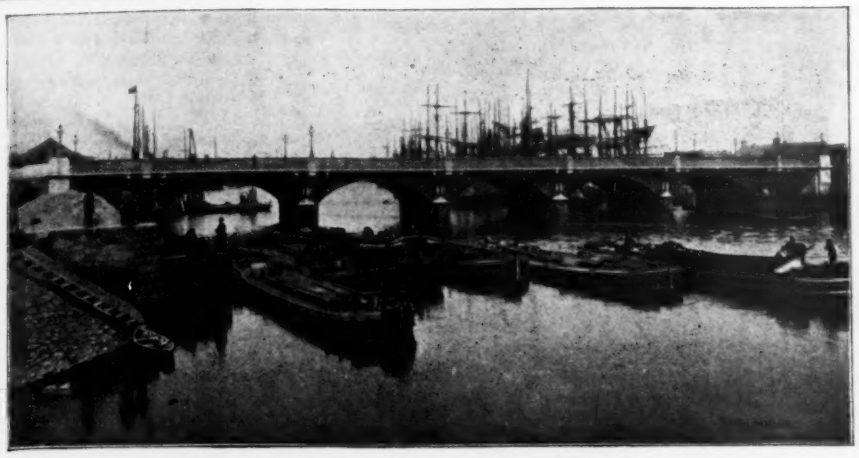


FIG. 5.—QUEEN'S BRIDGE, BELFAST, IRELAND.

the city, as described by General Ludlow, was frightful. There were several thousand reconcentrados in and about the town, who had been herding like swine and perishing like flies. Thousands of others of the population were in dire need of food, clothing and medicine. The regular service of the city was practically paralyzed. Street cleaning, at the best a farce, was entirely suspended, and the houses of assistance and hospitals were destitute of resources, and even of food. No sanitary measures or rules were in force,

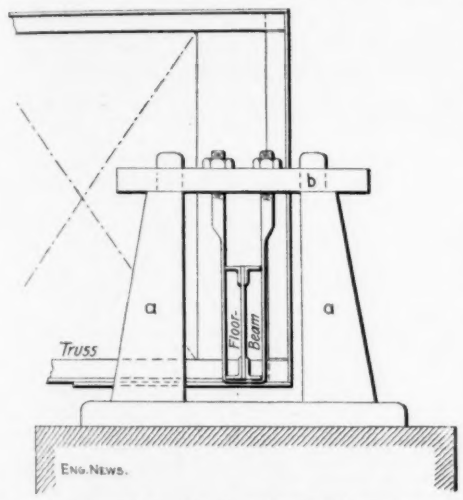


Fig. 4.—Expansion End of Railway Bridge Over Logan River, Belfast.

and the thronging population of soldiers, reconcentrados, natives and citizens used the streets or any open place for the deposit of refuse and filth of all kinds. It was nearly the same with all other branches of the city administration. Officials, clerks and employees had been unpaid for many months, and the public offices were practically abandoned. To accentuate these conditions, there were thousands of Cuban soldiers and natives rejoicing over the defeat of their old enemy, and disposed to celebrate their new-born liberties with unbridled freedom. Finally, there were the criminal classes, who were ready to take advantage of the confusion to ply their nefarious occupations.

The measures for reforming these conditions were undertaken and carried out nearly simultaneously. They comprised the work of supplying relief to the destitute; the organization of a police service; the general sanitation of the city; the reorganization of the hospital service; the establishment of an adequate signal service, and, finally, the organization of a civil government.

At the outset issues of rations had to be made to from 20,000 to 25,000 persons, but these were reduced by degrees as the men were nourished into ability to work, and in the end by refusal to issue food to any but those who were incapable of obtaining it otherwise. Employment was furnished by the organization of the street cleaning and other sanitary work. At the time of the report, June 30, 1899, only about 6,000 persons were receiving relief, of whom 75% were invalids, aged people and young children. The total cost of this relief work for the six months was $149,002.

The organization of the police force was begun by appointing a body of 350 Cuban soldiers to act as a mounted police for the rural districts. These rural police received cavalry pay, with an extra allowance for forage and rations, and for the use of their horses and arms, and were made responsible to the Chief of Police of Havana. This organization has answered its purpose admirably, there being practically no criminality or brigandage within the limits of its jurisdiction since it was organized. The organization of the city police force was based upon the practice in American cities, the rules and regulations being a modification of those in force in New York city. The force consisted on June 30, 1899, of 39 chiefs and officers and 408 policemen, all of whom were Cubans. At first the Cuban population, remembering the Spanish predecessors of this police force, were disposed to look upon the new policemen as enemies, to be both feared and hated, and conflicts between the two were frequent, but this feeling gradually died out. Regarding the police themselves, Gen. Ludlow remarks naively:

> The Cubans are of an excitable temperament and the police at the outset failed of that calmness and effectiveness which were essential. Pistols were too freely drawn and used, and the shooting was not very straight, but these defects were eliminated by degrees, and the men rapidly improved in steadiness and efficiency.

After the relief of the sick and starving, and the ensuring of public order and safety by thoroughly policing the city, the most pressing need was the improvement of its sanitary condition. Preliminary remedial measures were undertaken as soon as American troops were landed in Havana, but on Jan. 2 the work of sanitation was undertaken systematically under the direction of Maj. Wm. M. Black, Corps of Engineers, U. S. A., in charge of the engineering side of the work, and Maj. John D. Davis, Brigadier Surgeon, U. S. V., in charge of the medical sanitary work. The problems which faced these two officers, and the methods by which their solution was attempted constitute for engineers the most interesting portion of Gen. Ludlow's report.

The first work of Maj. Black was to organize an Engineering Department. As organized this department consists of: (1) A general office force, including a Record Division, a Voucher Division and a Property Clerk's Division; (2) Department of Streets; (3) Department of Water and Sewers; (4) Department of Works of the Port; (5) Office of the Municipal Architect; (6) Department of Renovation of Buildings, and (7) Department of Mechanical Engineering. The work of each of these departments is considered separately in the report.

Sanitary Engineering Work.

Department of Streets.—The work of street cleaning was begun as soon as the American troops took possession of any part of the city, so that by Jan. 1 the worst of the accumulated deposits of refuse had been removed. As at present organized the city is divided into twelve districts for street cleaning purposes, each of which is under the charge of an Inspector, with three General Inspectors over the entire city. These districts are subdivided, and a certain given space is allotted to each gang of laborers under the charge of a foreman. All of the principal streets are cleaned at least once daily, and the remaining streets are gone over from once to three times each week. The streets are swept by hand, and the sweepings are gathered up by carts and conveyed to scows for removal to sea.

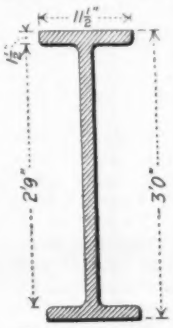


Fig. 7.—Section of Cast-Iron Arches of Albert Bridge.

Some of the streets are paved with stone on earth foundation, and some are macadamized. The stone pavements are exceedingly rough, and as the earth works up through the joints it is impossible to keep them perfectly clean. The macadam streets were badly in need of repair. Some details of the street cleaning work tabulated from information given in the report are given in Table I.

When work was first begun, the paved streets were exceedingly rough and full of holes. Apparently no system of grades has ever been adopted for the city, and there is no map showing the contours accurately. This, combined with the absence of a proper sewerage system, and the defective water system, has made it inadvisable to lay permanent pavements for the present, and the work of the Department has been confined to repairing the holes in the paved streets and to macadamizing to the extent necessary for sanitation, also in replacing the pavements where broken to permit work on water and gas mains and on sewers. The city is divided into three districts, with a paving gang assigned to each. The department is making a map of the city with the intention of laying out a system of street grades. Experimental pavements are being laid, consisting of sheet asphalt with a 6-in. concrete base, vitrified brick with a 5-in. concrete foundation, and asphalt blocks with a 4-in. concrete

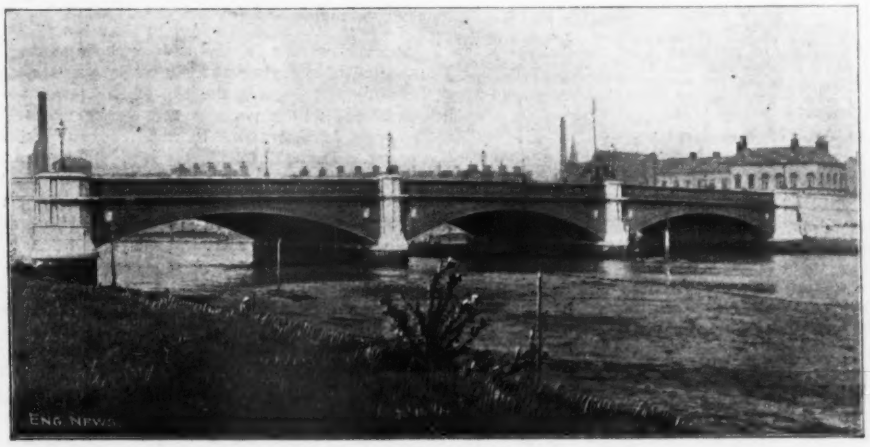


FIG. 6.—ALBERT BRIDGE, BELFAST, IRELAND.

TABLE I.—Statistics of Paving and Street Cleaning in Havana.

	City. Districts 1 to 6.	Suburban. Districts 7 to 10.	Regla. Dist. 11.	Casa. Blanca. Dist. 12.
Area paved with stone, sq. m.	479,087	3,300	....	....
" " " wood, "	5,219	....	....	....
Unpaved streets, sq. m.	625,292	361,339	112,036	11,220
Total area of streets, sq. m.	1,109,598	364,639	112,036	11,220
Area cleaned 6 times a week, p. ct.	84.6	....	....	....
" " 3 " " "	3	75	....	....
" " 2 " " "	1	....	....	....
" " 1 " " "	....	25	....	....
" " once a day, p. ct.	6.1	....	112,036	11,220
" " twice " "	6.2	....	....	....
Cost of cleaning, cts. per sq. m.	36	66.3	45.8	66.3
Sq. m. of street per cart load refuse	9,400	1,300	4,000	....
Average area cleaned per day's labor	2,500	1,100	3,500	....

Total area of streets in Havana .....1,474,237 sq. m.
Area paved with stone blocks ..... 482,387 "
" " " wood " ..... 5,219 "
" of unpaved streets ..... 986,631 "

foundation. From Jan. 1 to June 30, 1899, 41,731 sq. m. of granite block paving, 3,204 sq. m. of sidewalks, and 102,956 sq. m. of macadam were repaired. Macadam work consisted of repairs and renewals, the cost of the former being 58 cts. per sq. m., and that of the latter, $1.44 per sq. m. The cost per sq. m. for repairing granite paving block was 69.2 cts.

During January and February the garbage was collected by contract, but after that it was taken in hand by the Department, which purchased the contractors' plant, and added to it. All garbage is collected between the hours of 11 p. m. and 6 a. m., and the Municipal Ordinances require that before the hours for collection all house garbage shall be placed in receptacles on the sidewalk outside the doors. Very few houses are as yet provided with the proper cans, and in many cases the garbage is simply dumped in the streets, thus increasing the cost of collection. No attempt is made to separate the garbage from the other house refuse. Since Jan. 1, 374,879 tons of garbage and street sweepings have been collected, together with 5,962 tons of night soil and slaughter-house refuse, making a total of 380,841 tons. The cost of collecting this garbage was $1.99 per ton. Regarding the method of disposing of the garbage, the report says:

Early in January, it was found that the method of garbage disposal in use by the old regime (that is, by taking it to the country), would have to be abandoned for sanitary reasons, and it was determined to carry the garbage to sea until a better arrangement could be made. The Tallapiedra Wharves, lying immediately in front of the old Spanish Military Hospital, were selected for the dump, as being those which could be used for that purpose with the least degree of inconvenience and annoyance to the citizens. Two dumping platforms have been built on these wharves. At first, the necessary tugs and scows were hired; later, four scows were purchased and one was received by transfer from Key West, and a tug was bought. In May the garbage crematory, situated in the rear of the wharves, was finished, and since that date a portion of the garbage has been burned daily. The crematory is of the Davis pattern, with a maximum capacity of 100 tons per day. It has not yet been accepted, as some slight alterations were found to be necessary, owing to the character of the garbage to be consumed. It does its work well, however, and consumes whatever garbage is placed in it without causing any odor. The ordinary garbage collected from the houses is almost entirely vegetable refuse; it is very light and burns easily; but it is intermingled with broken crockery, bottles, old iron and debris of all kinds, which could not be separated without too large an expense, at present. In addition to this garbage, a portion of the refuse from the slaughter-house is burned. The night-soil from the cesspools in the city is carried to sea and dumped; using an iron dump scow belonging to the Obras del Puerto. Although the Tallapiedra Wharves have, for a long time, been considered the most unhealthy portion of Havana, no cases of illness have occurred since their use as a dump. This is partly owing, no doubt, to the disuse and cleaning of the Hospital Militar; but in part also to the cleanliness enforced in that vicinity by the Superintendent of the dump, and to the abundant use of disinfectants; the scows being sprinkled with lime, as they are loaded, and all carts disinfected when they unload. Since Jan. 1, 361,949 tons of garbage and night-soil have been carried 5 miles out to sea and dumped. The cost of dumping at sea is 35 cts. per ton, and 2,403 tons of garbage have been cremated.

In respect to street work generally, the pressing need is to devise a proper system of grades and to conform the street surface to it. At present valley lines are frequently found in the middle of a block. In other places so much water is poured into a single street during rains as to cause it to become a torrent. A smooth impervious pavement is also a sanitary necessity.

Water and Sewer Department.—The redeeming feature of the city engineering is the water supply, which, intercepting a portion of the flow of a magnificent spring on the banks of the Almendares River, at Vento, eight miles south and west of Havana, brings into the city through subterranean masonry conduits a supply of clear and wholesome water, almost pure organically, though hard from limestone in solution. The distributing system is defective, and the reservoir capacity is entirely inadequate. Improvements will have to be made at once. The waste of water is very great. Measurements made at the reservoir show that 41,424,000 gallons are delivered daily by the aqueduct. Of this amount about 5,645,000 gallons are wasted daily at the reservoir. Assuming a population of 204,000 for the city, this daily consumption and waste averages 173 gallons per capita. Many repairs have been made to the waterworks, and especially to the distributing system. The total expenditure of the Department on this item has been $34,705.

The report states that the water supply will have to be increased at no very distant date, and it is probable that the entire distributing system will require renewal. The house service pipes must be renewed throughout the city, and new plumbing and fixtures installed. All hotels, stables, manufacturing establishments and cafes, requiring large quantities of water, should be metered.

No plans could be found, nor could any of the officials under the old regime give any intelligent information concerning the extent and condition of the city's sewer system. Gangs of men had, therefore, to be set at work opening test holes in principal streets in order to secure this information. So far as discovered up to June 30 there were 35 miles of sewers in the streets of Havana. Owing to the light grades a heavy deposit of sludge was found in nearly all instances which had been accumulating for many years, apparently without any attempt having been made to remove it. The sewers are rectangular in section, and are designed without regard to uniform plan or system, but with a view of removing the sewage from some special locality. Owing to defects of cross-sections, of construction and of grades, they are in effect lines of cesspools.

The sides of the sewers are made of dressed rectangular blocks of coral rock, and they are covered with heavy stone of the same material, which in large sewers are supported on iron beams. The bottom has no lining of any kind, which permits a large percentage of the foul liquid matter to percolate into the surrounding soil, which is of gravel and disintegrated lime rock. The catch-basins are located generally at street intersections and are directly over the top of the sewer in the center of the street.

For the work of cleaning the sewers the city was divided into three districts, each under the supervision of an Assistant General Foreman. A force of about 400 men, divided into gangs of 25 to 30 laborers, with a foreman, does the cleaning. The method of carrying out the work consists, first, in making openings in the top of the sewer every 15 to 20 ft., which permits the workmen with their shovels and scrapers to reach every part of the sewer. Immediately after the sludge has been cast on the side of the opening it is covered with quicklime, loaded into carts and removed to the dump scows, by which it is conveyed to sea. Besides this general cleaning there were many special and urgent cases of obstructed sewers which needed attention, and the method adopted naturally differed with the different circumstances of each case. Up to June 25, 1899, the Department had cleaned 48,680 m. of sewers, removing 15,338 cu. m. of sludge and using 112,379 lbs. of quicklime. The total expenditures amounted to $34,933.

On March 23 a department was organized for cleaning the cesspools of public buildings. Six sanitary carts made of iron with close-fitting lids and a large double-tank wagon with hose and pump attachments were purchased for this w... With this apparatus 55 cesspools under the f... of 18 public buildings were cleaned of 1,340 cu... of matter. Regarding private cesspools and h... plumbing, the report says:

After the public cesspools were cleaned, the Depart... offered to remove the contents of private cesspools ... blackholes, charging an average fee of $5 per cu... Under this arrangement, 104 cesspools have been cle... These cesspools are holes varying in diameter and ... from 1 to 2½ m. and from 1 to 3 m. in width. They ... generally located in the center of the small court or ... the floors of the rear rooms. In some cases they ... curbed or lined with limestone or wood. Many are ... tirely unlined. The walls being thus permeable, ... sewage percolates through them, contaminating the ... under the floors of the building. The system of clean... by private individuals, in vogue, is most unsanitary. A cart with two or three empty casks is placed in front of the building, the contents of the cesspool are carried in an open bucket through the living apartments of the house and emptied into the casks. The casks were formerly dumped on a suburban farm for fertilizing purposes. Owing to the crude method thus employed and the excessive charges made by the private contractors, the Department deemed it expedient to offer the service of the public carts for this work. This had the effect desired of reducing the price and of causing some of the night-soil contractors to improve their methods. Private night-soil contractors are now required to take their carts to the City Dump.

A very important part of the work of this Department has been the inspection and supervision of plumbing arrangements in private houses. In the best arranged houses the plumbing consisted of water-closet and bath fixtures with soil and waste pipes emptying into a closed vault, which was made air tight and water tight, where the contents were supposed to thoroughly decompose. An overflow vent for liquids was placed near the top of the vault, and from time to time, as the vault became filled with solid matter, it was cleaned by hand. Backventing of the soil pipes and fixture traps was unknown. No drains of circular cross-section were in use, except in the case of a few vertical pipes. When the American occupancy began there was no vitrified clay sewer pipe in Havana. The drains, both vertical and horizontal, were generally rectangular in cross-section and built up of tiling. In spite of the fact that the masonry constructions throughout the city in general are exceptionally fine, these drains were frequently broken. The many joints permitted the liquid contents of the drains to escape and the defective type of cross-section caused the solid materials to be deposited in the drains, which, in almost every case, when opened were found to be exceedingly foul. The efforts of the Department have been directed to securing a proper arangement of interior plumbing, using cast-iron or vitrified clay pipe for the drains, trapping, backventing and ventilating the soil and waste pipes.

In concluding its remarks concerning the defective sewerage system of Havana, Major Black makes the following statement which will be interesting to our readers in connection with what has been said on the same subject by Gen. Francis V. Greene, M. Am. Soc. C. E.; the late Col. Geo. E. Waring, and Mr. E. Sherman Gould, and published in our issues of Jan. 12 and Aug. 3, 1899:

An entirely new sewer system is probably the improvement most needed. The existing sewers are fatally defective in every particular—size, shape, construction, grade, outfall, and even intakes. The new system will probably have to be a combination of the "combined" and "separate" systems. Until more is known of the movements of the offshore currents, and of the grades to be given the streets, the details of the system cannot be devised properly. It is certain that the sewage should not be permitted to flow into the harbor untreated, and that portions of the city cannot be provided with sewers until a high-service water system is installed. It seems possible that the expensive tunnel under the bay, heretofore projected, may not be required. The sewer work should be the first inaugurated in order that the new paving or water pipes need not be disturbed when placed.

Medical Sanitary Work.

The work of this Department has consisted in the inspection and cleaning of house cesspools, bakeries, stables, hospitals, markets, factories, etc., which were almost universally found in a dangerous state of filth and forming a constant menace to health. About 10,000 cesspools and privy-pits were found in the rear of the premises, often in the immediate vicinity of the kitchen. Many of these were overflowing, and some of them had not been cleaned in 50 years. These cesspools and pits have been cleaned and disinfected, and over 3,000 of them replaced by water-closets. The other places mentioned were also cleaned and disinfected, and new and more sanitary measures and habits enforced. It has been made compulsory for physicians to report cases of infectious diseases. The disinfectant chiefly employed was mercuric chloride.

In reviewing the work of the engineering and medical sanitary departments, the report points out that it has not been of a permanent character, and must be continued through a long period of time before the city can be rendered free from infectious diseases. The net results of the work done seem to be shown by the decreased death rates exhibited by the accompanying table. These figures are for the municipality of Havana alone, but those for other municipalities under Gen. Ludlow's control show still greater improvements. The report considers that the only points of dif-

ference to which the decreased yellow fever death rate of 1899, as compared with the average of previous years, can be credited are: (1) The general and thorough cleansing to which the streets of the city have been subjected; (2) the very numerous and thorough disinfections that have been made in both public and private buildings, and (3) the practice of a complete isolation of the patient and the disinfection, or, in many cases, the complete destruction of his effects.

General Engineering Work.

Works of the Port.—The work of this Department has consisted of repairing the wharves and bulkheads, of dredging out certain of the slips, and in cleaning, by dredging, the exceedingly foul Slaughter-House Creek. The total expenditure of the Department in this work has amounted to $42,433. The improvements deemed necessary for the harbor include a continuous sea wall with solid filling in the rear, the construction of piers, the filling of the low land around the head of the bay, the dredging of the shoals in the deeper portions, etc. It is believed that if the continuous deposit in the harbor of filth from the sewers is stopped, it will not take long for the harbor to purify itself, without the aid of artificial work.

Building Repair and Renovation.—The work of the two departments having the task of repairing and renovating public buildings has consisted in disinfection, cleaning, putting in new plumbing and other fixtures, and conducting a great variety of general repairs. These buildings were practically stripped of everything portable by the retiring Spaniards, and were veritable shells when taken over by the Americans. The work of putting them even partially in condition for the uses for which they were designed was a difficult one.

Mechanical Department.—This Department has prepared specifications in detail for a 15,000 incandescent light plant, for a water supply pumping station for Casa Blanca, and has installed an Electrozone plant designed to supply "Electrozone" for disinfecting purposes. This material and process were fully described in Engineering News of July 10 and 27, and Aug. 3 and 10, 1893, and March 22, and Aug. 2, 1894. Referring to this plant, the report says:

The reasons for its installation are found in the necessity for providing for a supply of disinfecting fluid in any quantity which might be required, at a minimum of expense, and with a reasonable certainty that the supply could not be interrupted by the exigencies of commerce. Investigation showed that "Electrozone," so-called, filled these requirements, the only commercial product required being the coal for the boilers. The disinfectant, a solution of hypochlorites, is made by passing a current of electricity through sea water. Regarding the efficiency of the disinfectant, it was found to have been used successfully in New York at Rikers Island (Eng. News, Aug. 2, 1892), and during sewer construction, etc., at Brewsters, New York, for purifying sewage, at Philadelphia by the board of health, and at numerous points abroad. It was commended highly by many sanitary experts, including some in the Marine Hospital Service of the United States; and finally was roughly tested at Havana by the Chief Sanitary Officer.

The Electrizone plant consists to-day of a frame building, 60 × 100 ft., with corrugated iron roof, and a shed 25 × 60 ft. built on the terreplein of the fort originally known as Fort Cuba, which formed one end of the old Puerta de la Punta of the wall which at one time surrounded the city of Havana. The steam generating plant is placed in one of the casemates, beneath the engines, and coal is stored in two other casemates. The following is a description of the plant:

There are two horizontal return tubular boilers, set in masonry, 72 ins. in diameter, 18 ft. long, with a guaranteed capacity each of 140 HP., at a steam pressure of 100 lbs., and two plain, slide valve engines of 125 HP.

These engines are belted to a 5½-in. line shaft, and belts from this shaft drive the generators. These were made by the Crocker-Wheeler Co., and will deliver 4,250 amperes each, with a potential of 12 volts. The exciter dynamo is an 18-K-W. machine, 125 volts, 144 amperes, and will be capable not only of exciting the dynamos, but also of lighting the building. The four main generators run at a speed of 175 revolutions.

There are nine vats, or tanks, made of cypress, circular, and bound with iron bands. In these vats are placed 417 platinum electrodes (positive), 425 zinc electrodes (negative) bought from the inventor of the process, Mr. A. Woolf. The tanks are in groups of two arranged in series, with one extra one for storage. The salt water for the electrozone is pumped direct from the harbor entrance channel.

Half of the plant has now (June 30, 1899) been running for the past week, and it is found that, on superficial test, varying with the cleanliness of the electrodes, there can be made in one hour, 1,000 gallons of Electrozone for each tub, varying in strength from 60 to 95 grains of available chlorine per gallon. The available product varies in quantity from time to time, owing to the fact that it is the amount of electricity, i.e., the amperage (not the voltage).

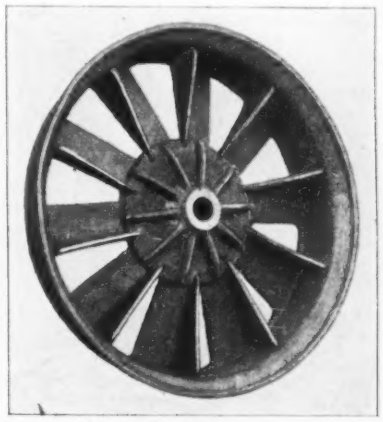
It is found that with the same voltage the quantity of electricity which a dynamo will pass through the electrodes of two tubs in series will drop from 4,000 amperes to about 3,000 amperes, if everything is not bright, and all connections absolutely clean. It is believed that this plant will be able to make about 75,000 gallons of electrozone in ten hours, or 160,000 gallons in 24 hours, without crowding, with a strength of about 90 grains of available chlorine to the gallon. In testing for available chlorine, Fresenius standard solution arsenius acid was taken as a neutralizing agent, starch iodide paper being used to determine neutrality; the assumption made by Mr. Woolf being that equal parts of electrozone and arsenius acid in neutral solution show 22 grains of available chloride to the gallon of electrozone. A careful analysis is now being made of this product.

The report closes with a description of the work of organizing the signal service, and of various technical questions concerning the army commissariat, medical service and care of soldiers in tropical countries, and outlines fully the form of civil government which has been gradually established.

PRESSED STEEL WHEELS FOR HAND CARS.

Pressed steel wheels have been used for some time past for railway hand cars and track velocipedes, and in most of these the center is a dished plate having portions cut away. The accompanying cuts represent a new form of wheel having spokes which support the whole width of the tire, and in which none of the metal is removed. In the process of manufacture, cuts are made in the plate at both ends and one side of each spoke, and the metal thus separated is pressed back at right angles to the face of the wheel. The hub is cast upon the plate, embracing the ends of the spokes and forming a very solid connection, without the use of bolts or rivets. Mr. James Donovan, of Three Rivers, Mich., is the inventor and patentee of the wheel, which is manufactured by Roberts, Throp & Co., of Three Rivers, Mich., in connection with their hand cars, track velocipedes, etc. These wheels are usually 16 to 20 ins. in diameter.

Face of Wheel.



Back of Wheel.

The Donovan Pressed Steel Wheel for Hand Cars. Roberts, Throp & Co., Makers.

SIXTY YEARS' PROGRESS IN MARINE ENGINEERING.

In his late address before the British Association for the Advancement of Science, at its Dover meeting, Sir William Henry White, Director of Naval Construction of the British Navy, reviewed the progress of steam navigation in the last 60 years. As a summary of this progress in the transatlantic service, he said that speed had been increased from 8½ to 22½ knots; since 1840, the time of voyage had been reduced about 38%; ships had more than trebled in length, about double in width, and increased tenfold in displacement. The number of passengers carried had grown from about 100 to nearly 2,000; the engine power was forty times as great; the ratio of horse-power to the weight driven had increased fourfold; while the rate of coal consumption by horse-power-hour, was now only about one-third of what it was in 1840. At that time it took about 550 tons of coal to drive 2,000 tons across the Atlantic at a speed of 8½ knots; now, 3,000 tons of coal will drive 20,000 tons at a 22-knot speed. With the low steam pressure and heavy, slow-moving paddle engines of 1840, each ton weight of machinery and boilers produced only about 2-HP. for continuous work at sea; while with modern twin-screw engines and high pressure, one ton of propelling plant produces 6 to 7 HP.

Sir William remarked that it would be idle to attempt to predict the characteristics of ocean navigation sixty years hence. But he believed that radical changes would be made in that period. In the lines of advance he anticipated further reductions in the weight of the propelling apparatus and fuel, in proportion to the power developed; the use of stronger, and hence lighter, material in the hull, and improved structural arrangement; but he thought that greater draft was essential for the greater carrying power and speed; although here, commercial considerations and the needs of naval warfare must decide. The recent use of water-tube boilers in warships has already saved one-third of the weight necessary with the ordinary cylindrical boiler, with same power with natural draft. Greater safety and quicker steam-raising qualities are also secured. But no great economy in coal consumption is expected from the water-tube boiler, and skilled stoking seems essential. Sir William, therefore, thinks we must look to liquid food, which has many obvious advantages over coal, especially in the transportation of the fuel, to the ship and to the boilers. Even if the saving in weight for equal evaporation is put as low as 30% of the corresponding weight of coal, the use of liquid fuel on an Atlantic liner

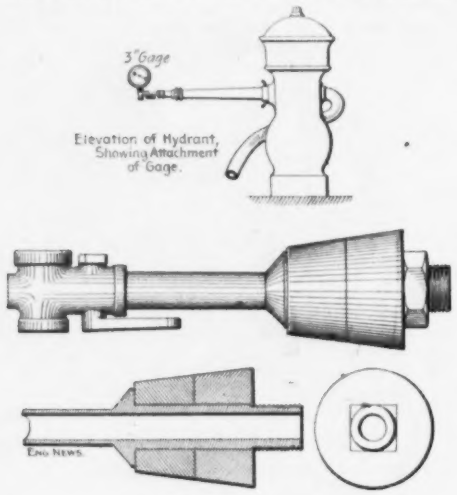
TABLE II.—Showing Total Deaths and Deaths from Yellow Fever in Havana, Cuba, for Each Month from 1890 to 1899, Inclusive.

Month	Deaths.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Total	All causes	7,432	7,105	7,185	6,831	6,730	7,410	11,728	18,123	21,235	.....
	Yellow fever	327	363	362	512	418	570	1,540	1,056	162	20
January	All causes	441	623	635	620	550	642	547	1,562	1,805	1,260
	Yellow fever	8	10	15	15	10	15	10	98	10	1
February	All causes	463	523	530	442	470	542	592	1,425	1,607	843
	Yellow fever	4	4	11	7	6	4	9	28	2	0
March	All causes	560	554	554	510	509	526	687	1,385	1,494	811
	Yellow fever	4	4	2	5	2	2	5	44	3	1
April	All causes	531	611	594	563	467	591	743	1,121	1,403	648
	Yellow fever	13	5	8	7	5	7	13	77	3	2
May	All causes	669	581	621	594	536	618	820	1,111	1,364	635
	Yellow fever	29	7	7	26	17	10	29	96	5	0
June	All causes	829	601	646	644	540	676	881	1,089	1,233	639
	Yellow fever	47	41	13	70	37	19	47	183	3	1
July	All causes	869	638	581	720	708	744	1,095	1,276	1,560	680
	Yellow fever	70	64	29	125	91	92	120	209	16	3
August	All causes	635	614	668	602	694	686	1,270	1,530	1,973	620
	Yellow fever	48	67	70	95	77	124	272	121	22	11
September	All causes	619	545	575	567	536	602	1,067	1,548	2,414	..
	Yellow fever	34	66	70	72	79	136	178	74	37	1
October	All causes	700	533	579	543	539	622	1,208	2,103	2,477	..
	Yellow fever	37	50	52	47	45	103	267	67	33	..
November	All causes	547	569	641	503	566	529	1,399	2,058	2,051	..
	Yellow fever	22	28	53	33	25	30	365	42	15	..
December	All causes	539	713	561	523	615	572	1,419	1,915	1,854	..
	Yellow fever	11	17	32	10	24	19	225	17	13	..

would mean the saving of 1,000 tons in load carried. This saving might be utilized in greater power, higher speed, or increased cargo. He does not believe, however, that adequate supplies of liquid fuel are now available, and present prices would not justify its adoption. Stronger materials of construction are already available; and alloys of steel with nickel and other metals are now made which would give strength and rigidity superior to the mild steel that has so recently replaced wrought iron. This stronger material is now more costly, but he estimates that in an Atlantic liner of 20 knots speed, about 1,000 tons could be saved by substituting nickel steel for mild steel; this saving in dead load would suffice to raise the speed one knot without altering dimensions. Alloys of aluminum effect considerable saving in weight, but they seriously corrode when exposed to sea water; other alloys will probably be found free from this defect and yet uniting lightness with strength. As a conclusion, Sir William is confident that ocean steamers have not reached their maximum dimensions, and that we may confidently look for larger vessels than any now afloat.

A DEVICE FOR ATTACHING PRESSURE GAGES TO HYDRANTS.

One of the best indications of the good management and general efficiency of a water-works plant or fire department is the extent to which the official in charge keeps his finger on the pulse of the system. He should not only know the total consumption, day by day, but its fluctuations from hour to hour, and how it is distributed over the city. In like manner he should not be satisfied with a recording pressure gage at the pumping station, but should have a number of these at points of varying pressure; and besides this, it is important for both the water and fire departments



Attachment Fitting, Half Size.

to make frequent observations of the pressure at each fire hydrant connected with the system, when not in use and at times of fire.

A simple and convenient fitting for attaching pressure gages to fire hydrants is shown by the accompanying illustration. The fitting may be attached directly to the hydrant or used at the end of a hose nozzle. In the latter case the fitting drops into place through the large end of the nozzle and is immediately ready for use. By changing the rubbers the same fitting may be used on ¾ to 1¼-in. nozzles, and one rubber serves for either a 1¼ or 1¼-in. nozzle. The fitting may be taken apart or attached to a hydrant without using wrenches, the rubbers being made with square holes to fit a square shank, thus serving as a handle for screwing or unscrewing the parts.

By changing the parts about, the device may be used with either a ¼ or ⅛-in. tap in the hydrant, the rubber end of the tube having a ¼-in., the tee end a ⅞-in., and the two branches of the tee ¼ and ⅛-in. threads, respectively. The stop cock permits the use of a ¼ or a ⅛-in. gage, or both sizes, or of shutting off the water entirely.

The fitting was devised by Mr. F. B. Sanborn, Inspector with the Factory Mutual Insurance Co., and is made by the American Steam Gage Co., 36 Chardon St., Boston, Mass. While any diameter of gage may be used with it, the 3-in. size is said to be most convenient, with ⅛-in. connection. The combined cost of a gage and outfit being considerably less than ten dollars, the attachment being so simple, and the advantages of frequent pressure readings so great, an extensive use of the device may be expected.

A RAILWAY ACROSS THE SAHARA, from Algeria to the Niger River, is once more being seriously discussed by the French government engineers. A preliminary survey has been made by the Foureau-Lamy expedition, and the relative African claims of France, England and Germany have been definitely settled by treaties, which leave France in possession of the Niger in all its upper waters. As projected, the desert line would leave Biskara, in Algeria, and pass south and southwest to Tugurt and Wargla, and then almost due south over the arid desert, over the Timmo Mountains, and to the group of oases at Air, or Agades. From the latter point branch lines would reach Lake Tchad, on the southeast, and the Upper Niger Valley to the southwest. The length of the desert portion of the line would be not less than 1,250 miles, and the cost is estimated at $60,000,000, on the basis of the experience gained in building the trans-Caspian railway through desert country. It is admitted that work will be both dangerous and costly on this treeless, waterless, sandy waste. On the Upper Niger, from Kayes, at the head of navigation, to Dinbeba, 30 miles beyond the mouth of the Bafing River, a railway is already built, though great difficulties were encountered.

THE NAVAL ESTIMATES for the fiscal year ending July 1, 1900, amount to $73,045,183. This is an increase of $24,537,157 over the appropriations for the current year. Of this total, vessels to be commissioned within 18 months require $22,983,101 for machinery, armor, armament and equipment, and the Bureau of Yards and Docks ask for $12,268,474 for work at the six principal navy yards. The remaining half of the appropriation asked for is divided among the other bureaus in amounts ranging from $2,700,370, for the Marine Corps, to $6,503,124, for the Bureau of Ordnance. The purchase of provisions require $4,000,000, and the pay of the officers and men of the Marine Corps alone represents $1,694,054. Spanish is to be taught at the Naval Academy by a separate professor, instead of having it taught by the professor of French, and this accounts for the appropriation of $2,000.

AN 8-IN. OIL-PIPE LINE, 143 miles long, is being now finished, to convey petroleum from Michailovo to Batoum, along the Trans-Caucasian Railway, says the "Praktische Machinen-Constructeur." There are three elevating stations on the line, each fitted with compound lifting pumps, of 150 HP. each. The daily duty of the pumps is 90 metric tons of petroleum, or a maximum of 25,000 tons per year. The pipe line is covered with ballast, and it is fitted with safety-valves at every 3 km., that automatically isolate each 3-km. section in case of accident. At Michailovo the oil is brought from the wells in cistern-wagons, which discharge directly into iron troughs leading to two tanks holding 12,000 cu. m. of oil. At each of the three pumping stations there are three similar reservoirs, one extra for repairs. At the Batoum terminal there are eleven reservoirs, having a total capacity of about 600,000 cu. m. It is expected that this plant will be in full operation by the end of this year.

THE HOLLAND SUBMARINE BOAT is still being tested at Greenport, N. Y. On Oct. 4, in a heavy rainstorm and with head winds, the boat made a submerged run over the mile course in less than ten minutes, while the rise for observation for changing position occupied only seven seconds. U. S. naval officers and Mr. H. Wellenkamp, a constructor in the German navy, witnessed the trials on board the vessel, and expressed the opinion that great improvements had been made within the last year.

PARTINIUM is said to be a new alloy of aluminum now being experimented with by de Dion and Bouton in the bodies of motor-vehicles, in Paris. The aluminum is alloyed with tungsten, and the resultant metal is claimed to have a specific gravity of 2.89 cast, and 3.09 rolled; the elongation varies from 6 to 8%; its tensile strength is given as from 45,500 to 52,600 lbs. per sq. in. It is said to be cheaper than aluminum, nearly as light, and to possess greater strength.

A NEW TREAMENT OF RAMI FIBER is being experimented with in Algiers on a process devised by M. Bachelerie. According to "L'Industrie Textile," the apparatus includes a closed vessel, in which is a cage holding 400 kilos. of green rami stems. A generator of carbonic acid is then placed under this vessel and communicating with it by a pipe. The green rami is submitted to the action of the carbonic acid for about 50 minutes, under a pressure varying form 1¼ to 1½ atmospheres. The rami is then taken out and completely dried in a stove at about 80° C., and it is dried in from 5 to 6 hours. With rami thus treated 400 kilos. of green stems gave 54.64 kilos. of fiber. The process is said to be very economical, and the use of carbonic acid under pressure for barking the rami stems is claimed to be absolutely novel. The removal of the fiber from the wood is performed by ordinary machines.

CIVIL SERVICE EXAMINATIONS for topographical draftsmen will be held at the rooms of the Municipal Civil Service Commission of the city of New York on Oct. 18. The examination includes handwriting, arithmetic, technical knowledge and experience. The salaries for this position range from $1,200 to $1,800 per annum. There are at present a number of vacancies to be filled, and as there is a scarcity of applications the persons successful in passing the examination are sure of appointment. Candidates who desire to enter the examination should address Lee Phillips, Secretary of the Commission, New Criminal Court Building, New York city, requesting application blank. Candidates may bring tehir own drawing instruments, etc.

ASSISTANT PATENT EXAMINERS are wanted by the Government Patent Office at Washington, D. C., and examinations of applicants will be held Oct. 17. The qualifications necessary to pass the examination are a knowledge of (1) physics, (2) organic and inorganic chemistry, (3) mathematics, (4) technics (test of knowledge of the manufacture of different articles and substances, etc.); (5) reading mechanical drawings, describing the construction and operation of machinery represented and the mechanical powers that appear, (6) translation of French or German into English. In view of the great need of eligibles, the commission will arrange to examine any one who will indicate, by wire or otherwise, his desire to be examined in time to permit of the shipment of papers to the place of examination, giving him sufficient time after the examination to file formal application. Upon receipt of request, copy of the manual of examinations, giving the full scope of the examination and sample questions, will be forwarded. The entrance salary to this position is $1,200 per year.

GAGING CEMENT WITH SALT WATER decreases its strength, according to experiments conducted by Mr. A. S. Cooper, and described by him in the "Journal of the Franklin Institute" for October, 1899. Mr. Cooper's tests were made with both natural and Portland cement mortars, and comprised both tensile and compressive tests. The briquettes were of the Am. Soc. C. E. recommended pattern, and were mixed and molded by machine. All conditions of manufacture and material were kept uniform. The briquettes gaged with fresh water were kept in fresh water and those gaged with salt water were kept in salt water. The ages of the briquettes when tested were one week, four weeks, three months, six months and one year. In the short-time tests the briquettes gaged with salt water stood ahead of those gaged with fresh water, but the long-time tests nearly always showed the superior strength of the briquettes mixed with fresh water, and this was just as pronounced in the compression as in the tension tests. The deteriorating effect of the salt water seemed to be the greatest with the richer mortars. The author considers that the results obtained would seem to justify the conclusion that the use of salt or sea water in gaging mortar is bad practice.

THE USE OF ARMED-CEMENT, says the "Annales des Ponts at Chaussees," has decreased the cost of small bridges from 227 and 288 francs to 40 and 80 francs per sq. meter of roadway. The new bridge at Mans, thus lately built, is 125 m. long and 4 m. wide, or 410 ft. by 13.12 ft. The cost of the bridge did not exceed 60 francs per sq. meter, or $1.11 per sq. ft. The stone bridge nearby, built in 1884, cost 392 francs per sq. meter.

THE BETON ARCHED BRIDGE OVER THE NECKAR, between Kircheim and Gemmbrigheim, says the "Annales des Ponts et Chaussees," for July, 1899, was built in 1895-97. It is a highway bridge with four arches of 124.6 ft. span each and 18 ft. rise; these arches have a depth of 2.95 ft. at the springing line and 2.62 ft. at the key. Each arch is hinged at both spring and key by lines of cut stone voussoirs with plates of lead between them. The width of the bridge, between the metal handrails, is 18 ft., including a roadway of 13.1 ft. and two footways. In calculating the resistance of the arches, a load of about 82 lbs. per sq. ft. was assumed, in addition to the weight of the beton. The faces of the arches are of cut stone voussoirs, with the spandrills filled in with irregular range masonry, with three tiers of small arches supporting the roadway. The beton used was made of 1 part cement, 2½ parts sand and 5 parts gravel. The total cost of the bridge was $46,600.

THE GRENIER BRIDGE AT BERNE, Switzerland, completed in 1898, has the following dimensions:

Total length	1,172.85 ft.
Height above low water	161. "
Width, c. to c., of balustrades	41.58 "
Width of roadway	23.76 "
Width of footways, each	8.91 "

The bridge consists of eight spans, of which the principal one is a parabolic arch of 484.6 ft. span and 104.08 ft. rise. The outside ribs of this arch are 26.4 ft. apart at the crown, and widen out to 44.22 ft. at the abutments. The roadway consists of galvanized metal troughs, upon which are laid concrete and wood blocks. The total cost of the bridge was about $349,200.

THE TEMPERATURE NEEDED FOR PORTLAND cement calcination has been made the subject of investigations conducted by Mr. R. Feret at the Boulogne-sur-Mer Cement Works. The mode of ascertaining the degree of temperature was as follows: Bars of hard steel up to 31 ins. in length were embedded in the contents of continuous kilns, which were known to work regularly and to yield cement clinker of normal quality, and in every case the steel vanished. A bar of square iron placed in the same kiln was found to have been melted away for about three-quarters of its length. Two bars of the same iron, each 6½ ft. in length, were placed vertically in a Hoffmann cement kiln, in two different places in the middle of the bricks of cement-material, and a certain distance away from the feeding holes, serving for the introduction of the fuel. After the calcination was completed, only about half of each bar was found. For various reasons given, it may be assumed that the temperature needed to produce cement clinker is above that of the melting point of steel, and corresponds very closely with that of wrought iron, viz., 1,600° C. It results from these experiments that a trial kiln for the study of cement mixtures should be capable of readily reaching a temperature of 1,800° C., because the pure mixtures would be devoid of the fluxes commonly present in the materials generally used for cement.

IRON FELT is a new insulating material made at the Aldershof Works, near Berlin, Germany. This felt consists of long and strong woolen fibers impregnated with a by-product of petroleum and then coated by a gelatine rendered insoluble. It may also be finally coated with india rubber and vulcanized. After being subjected to considerable pressure the iron felt assumes the form of plates, 20 cm. square, or more, and from 1 to 5 cm. thick. These plates are elastic and practically imperishable, and will stand a pressure of nearly 21,000 lbs. to the sq. in. The surface is so hard that it is not cut by the sharp edges of nuts and bolts, and it is proposed as a cushion under rails, or engine foundations, etc., to prevent vibration.

THE PROPOSED NEW YORK BUILDING ORDINANCE was passed by the city council on Oct. 10. This ordinance passed the board of aldermen about a month ago, and upon being signed by the Mayor will become a law. The general nature of the ordinance was given in Engineering News of Sept. 14, 1899.

NOTES FROM THE ENGINEERING SCHOOLS.

University of Wisconsin.—The College of Mechanics and Engineering has issued in pamphlet form its announcement for the term of 1899-1900. Special lectures will be given as follows: "Some Aspects of Water Purification," R. S. Weston; "Methods and Results of the Transcontinental Chain of Triangulation Along the 31st Parallel of Latitude," John F. Hayford, U. S. Coast and Geodetic Survey; "Mechanical Draft," Walter B. Snow, B. F. Sturtevant Co.

On Oct. 14, 1899, J. B. Johnson, at present professor of civil engineering, will be inaugurated as Dean of the College of Mechanics and Engineering. The Western Society of Civil Engineers will attend in a body.

Purdue University.—A lecture on "Ocean Telegraphy," will be given by Dr. A. E. Kennely, of Philadelphia, president of the Am. Inst. E. E., on the evening of Oct. 16, 1899, before the School of Electrical Engineering.

Michigan Agricultural College.—The course in mechanical engineering has been lengthened to five years, and a number of new subjects will be taken up.

University of Illinois.—A number of new courses in the Department of Electrical Engineering have been added in the fields of electro-metallurgy, alternating current working and polyphase testing, and electric lighting and power plants. The equipment of the Electrical Engineering Laboratory is being continuously increased for regular and advanced work in these branches. The four years undergraduate course has been made elective for the last year and a-half; that is, a student may elect his further work in: (1) Regular Electrical Course; (2) Electro-Physical Course; (3) Electro-Chemical Course. The degree of E. E. is given only after the completion of five years of work. The fifth year is devoted entirely to special work. The principal or primary subjects are elected from the advanced electrical engineering course; the secondary, or subordinate, subjects are elected from the advanced courses in mathematics, physics, chemistry and mechanical engineering. Prof. Wm. S. Aldrich, late of West Virginia University, is now in charge of the Department of Electrical Engineering.

Lehigh University.—New appointments have been made in the engineering department, as follows: Herbert Schneider, '94, instructor in civil engineering and architecture; Robert M. Wilson (Cornell), and Barry MacNutt, '93, instructors in electrical engineering.

An optional course of 400 hrs. in marine engineering and architecture is offered this year. Part of this work will be in charge of Professor Kline, while Amasa Trowbridge (Sheffield Scientific School), at present with Cramps, will conduct the remainder. There have been a number of important additions to the library on marine engineering and architecture.

Massachusetts Institute of Technology.—Since the end of the last term the following changes have been made in the faculty: Adolph Rambeau, Ph. D., will be professor of modern languages; Arthur A. Noyes, Ph. D., formerly associate professor of organic chemistry, will be professor of theoretical and organic chemistry; Jerome Soudericker, C. E., formerly assistant professor of applied mechanics, will be associate professor of applied mechanics; Allyne L. Merrill, S. B., formerly assistant professor of mechanism, will be associate professor of mechanism; Edward F. Miller, S. B., formerly assistant professor of steam engineering, will be associate professor of steam engineering; Carleton A. Read, who was instructor in mechanical engineering, has left to take charge of the mechanical engineering department in the College of New Hampshire.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The sixth annual meeting of the society was held at Toronto, Ont., Oct. 3 to 5. The sessions were held in the new City Hall, one of the finest municipal buildings on this continent. Mr. Nelson P. Lewis, of Brooklyn, the president, and Mr. D. L. Fulton, of Allegheny, Pa., the secretary of the society, officiated in their respective capacities during the convention.

After the usual addresses of welcome the president read his annual address. The importance of the subjects discussed by the society was illustrated by estimates showing that in 1898 the 112 largest cities in the United States raised $210,000,000 for public streets, water supply, sewerage, lighting parks, bridges, police and fire purposes alone. In the coming century, the president said, he hoped municipal affairs would take such a shape that there would not be, as this year, the spectacle of city engineers in three important cities of the Northwest resigning their positions, after years of faithful service, simply because of a change in the politics of the mayor of the city.

The reports of the secretary and treasurer showed total receipts for the year of $1,060, including $7 from last year, and a balance of $85 to be carried forward. A small debt was discharged during the year, and all bills falling due had been met. The number of members paying dues in 1898-9 was about 90, including fees from a few cities.

Report of the Committee on Electric Street Lighting.

By David Hunter, Jr., Chairman, Allegheny, Pa.

One of the main facts in this report was the suggestion that contracts for street lighting be based on meter measurement of current, instead of so much per lamp. Companies would then be financially interested in keeping the lights up to the standard of candle power or current consumed and in keeping down the number of lamps not burning. As to the relative price per lamp hour for lamps of different candle power, statistics from a fair number of cities were presented showing that the price for 1,200-c. p. lamps averaged 2.73 cts., and for 2,000-c. p. lamps, 2.81 cts. per lamp hour.

Pure Ventilation Through House Connections.

By Chas. B. Ball, M. Am. Soc. C. E., Inspector of Plumbing, Washington, D. C.

This paper came under the call for the report of the Committee on Sewerage and Sanitation. Mr. Ball favored, generally speaking, the omission of the main trap on the house connection, or at the foot of the soil pipe, in order to provide ventilation for the sewers. He thought it better to discharge sewer air above the house tops than at the street level, and that the integrity of the plumbing should be above suspicion in any case. A general discussion followed. The concensus of opinion was that it is safer to insert the trap and run a ventilating pipe up the side of buildings, rather than ventilating through the latter. Mr. C. H. Rust, of Toronto, said it had been found difficult there to obtain consent from property owners to place such pipes. Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., of Milwaukee, did not think it wise to omit the trap. Several speakers thought well-designed and constructed sewers were sufficiently ventilated by perforated manhole covers and other necessary connections with the outer air.

Report of Committee on Municipal Data.

By C. C. Brown, Chairman, Bloomington, Ill.

In the absence of Mr. Brown this report was read by Mr. A. D. Thompson, of Peoria, a member of the committee. The report renewed the suggestions of a year ago, including three model forms to be followed by officials in making reports. The branches of public work covered by the forms, and the authors of the latter, were as follows: Water-works, Mr. Brown; sewerage, Capt. Lansing H. Beach, Washington, D. C.; street paving, Mr. Thompson. The report proposed that when these forms were adopted by the society they should be transmitted to the Superintendent of the Twelfth Census, with a recommendation that they be used in the next census. A permanent census bureau was considered a desideratum. The committee had made urgent calls for criticisms of the forms throughout the past year, but had not heard from a single member of the society, nor did it know of any member who had used the forms in making up a report.

Mr. S. Whinery, M. Am. Soc. C. E., in response to a request, stated that the Board of Direction of the American Society of Civil Engineers, in accordance with a vote of the society, had taken steps to secure a provision for full municipal statistics in the next census. A committee has been appointed, of which Mr. Whinery is chairman, and has written to the census bureau on the subject, but thus far no reply has been received. Mr. Lewis, the presiding officer of the convention, said he had written a letter to the bureau, urging it to collect municipal statistics and offering the co-operation of the American Society of Municipal Improvements. Superintendent Merriam had replied that, in accordance with an act of Congress, special subjects, like municipal statistics, would not be taken up until population, vital, agricultural and manufacturing statistics had been disposed of. When the time arrived he would be glad to have the co-operation of the society. Mr. Lewis feared the model forms would paralyze the census bureau, and that they were too detailed for the adoption of municipal officials. Another speaker called attention to two tables of paving statistics published in "Municipal Engineering" for September, one having been compiled by that journal and another by a contributor. Six cities appeared in both lists, but the statistics for only one of the six agreed, the difference in one case being 50%. Doubtless the city officials involved tried to give correct information. These facts indicated the chaotic state of municipal statistics.

A resolution was adopted providing for the appointment of a special committee of five members of the society to take up the question of municipal statistics with the census bureau, co-operate with a similar committee from the American Society of Civil Engineers, and advocate the establishment of a permanent census bureau.

Several members having spoken of visits from agents of the United States engaged in the collection of municipal statistics, and there being some doubt as to the department from which they come, Mr. M. N. Baker, of the editorial staff of this journal, explained that Mr. Carrol D. Wright, U. S. Commissioner of Labor, was authorized by a recent act of Congress to collect statistics of cities of about 30,000 population and upwards; also that Mr. Wright, for the general government, and some of the labor bureaus of the several states, have been engaged for several years in collecting statistics regarding the relative advantages of public and private ownership of water-works and lighting plants. As to uniform water-works statistics, a number of works throughout the country have been, for years past, using a form adopted by the New England Water-Works Association, and the journal of that body has published yearly summaries of the figures given in the several reports. The only practicable way to secure anything like uniformity in municipal reports is through control by individual states, after some such plan as has been advocated by the National Municipal League. A permanent census bureau is necessary if much work is to be done by our national census. For the twelfth census, Mr. Baker suggested that the securing of a limited amount of information be attempted for all municipalities and fuller information for a few of the most important ones (as outlined editorially in Engineering News of July 27, 1899).

Report of the Committee on Taxation and Assessment.

By August Herrmann, Chairman, Cincinnati, O.

Mr. Herrmann presented tabulations of water rates charged in about 30 of the largest cities of the United States, and also a table designed to show the local conditions affecting cost of service. All but three of the cities having a population of 80,000 or more in 1890 were included. In general, the figures showed that Detroit had the lowest and New Orleans the highest meter and fixture

rates. Indianapolis, New Orleans and Omaha were the only cities under private ownership included in the list. Of 30 cities, 19 attempt no purification of the water, 6 are taking steps to that end and 5 report purification works.

Mr. Benzenberg thought that, all things considered, Milwaukee supplies water at a rate even lower than Detroit. About 26,000 of 34,000 services are metered. There is a flat meter rate of 6 cts. per 1,000 gallons and a minimum meter charge of $1 a year. Thousands of domestic consumers, on the basis of last year's consumption, will pay less than $3, including the minimum rate, for water this year. The works are in excellent financial condition, all expenses, including interest and sinking fund, being paid from the water revenue. In five years it is expected that the water debt will be cancelled, which will cut off 60% of the expenses of the department. An ordinance has long been in force providing for a credit to the water department on account of public services, but no credit has been made. Better things were promised by the city council when the flat rate of 6 cts. per 1,000 gallons was adopted.

A Plea for a More Liberal Policy Towards Property Owners Assessed for Benefit.

By Geo. T. Bouton, Jersey City.

The author cited the experience of Jersey City in support of his plea. Some years ago abuttors bore the whole cost of certain improvements, and petitions for such work became very few. Of late, the city bears part of the expense, and much more work is being done.

Report of the Committee on Electrolysis.

By Harold P. Brown, Chairman, Newark, N. J.

The report commented on the failure of copper rail bonds, both single wire and bunches of wire, where fastened rigidly to the rails. Every joint must yield somewhat as cars pass over it, and any copper bond, however flexible, will fail sooner or later, if fastened at the ends. the recommendations of a year ago were renewed, to the effect that there should be more co-operation and less hostility between city and street railway officials; and that in lines of water mains sections of wooden pipe, with iron bands, should be inserted at intervals.

Electrolysis from the Standpoint of the Municipal Electrician.

By H. S. Wynkoop, of Brooklyn.

The author thought the subject of electrolysis had been treated on too narrow a basis heretofore, investigations being conducted in the interest of a single department. He proposed an electrical bureau of nine members, with representatives from water, gas, electric and other interests affected, and a lawyer, chemist and electrical engineer in addition. Such a body should be given control of matters pertaining to the subject and would be able to handle the matter in an all-around way.

Mr. Thompson, of Peoria, said the water company of that city now has a suit in the U. S. court, to compel the street railway company to use the double trolley. Testimony has been taken by a referee from about every one in the country supposed to have information on the subject, but a decision has not been rendered.

Mr. Lewis said that in Brooklyn a guaranteeing asphalt contractor had refused to repair a defective pavement, alleging the deterioration had been caused by leaks from the gas mains, for which he could not be held responsible. The gas company, in turn, maintained that the leaks were due to electrolysis, for which the city was responsible, through not compelling the street railway company to take proper care of its current.

Mr. M. R. Sherrerd, M. Am. Soc. C. E., of Newark, said the trolley company there had paid half the expense of renewing service pipes affected by electrolysis, allowance being made for the fact that the services were old.

Report of the Committee on Street Paving.

By Edwin A. Fisher, M. Am. Soc. C. E., Chairman, Rochester, N. Y.

The committee, in a previous report, had given attention to the material used for paving and to street railway tracks. Its views on these subjects have met with general favor on the part of city and street railway officials. The present report related to the obligations of street railway companies on account of their use of the public streets and to the disturbances to paving caused by street openings in general.

Statistics published by the "Street Railway Journal" for February, 1899, showed 17,964 miles of street railway track in America, a total that illustrates forcibly the important part which street railways play in paving affairs. The committee believed that all paving should be laid and maintained by the city, rather than any part by street railway companies. The latter, instead of doing such work, should pay money into the city treasury for the use of the streets. The increasing use of motor vehicles led to the suggestion that owners of these vehicles should also pay for the use of the public streets. Before new paving is laid, all underground work likely to be required in the street during the life of the pavement should be done. Where possible, street paving contractors guaranteeing such work for a period of years should have some control over the refilling of trenches where the streets are opened. There should be a rigid system of controlling all openings in paved streets.

The Life of Pavements.

By Geo. W. Tillson, Brooklyn, N. Y.

When the yearly cost of repairing pavements exceeds a certain sum, varying with local conditions, it is more economical to repave the street.

That is, if the annual cost of the proposed pavement, including interest, sinking fund and repairs, is below the actual present annual cost of repairs, a new pavement should be laid. A careful study of available information led Mr. Tillson to conclude that the life of different classes of pavements is as follows: Granite block, 25 years on concrete and 20 years on sand foundation; wood, 10 to 15 years; asphalt, 18 years; brick, well vitrified and carefully laid, 15 years.

Contractors who guarantee pavements for terms of years understand that street car tracks concentrate traffic and increase the cost of maintenance. A recent Brooklyn bid for new asphalt, not including foundation, was 98 cts. per sq. yd. on streets without and $1.26 on those with tracks. Probably the best granite block pavement in the country is on the approaches to the Brooklyn Bridge, which has been in use over 16 years, without repairs.

The Physical Properties of Asphalt.

By W. H. Broadhurst, Brooklyn, N. Y.

Besides a general review of the subject, this paper included a description of tests for ductility, or non-brittleness, made on different kinds of asphalt. The asphalt was placed in small glass tubes, cut apart half way in their length and lightly cemented. The elongation of the material was measured by the pulling apart of the two half-tubes, under uniform conditions.

Damages from Non-Repairs of Highways.

By Jas. S. Fullerton, Toronto.

This paper discussed the subject from a legal standpoint. The author doubted whether better highways are secured by making cities liable for damages in civil action on account of accidents due to defective pavements and sidewalks. Such actions are not permissible in England. Numerous cases of fraud or attempted fraud in connection with such suits were cited by the author.

Creosoted Wood Block Pavements in Indianapolis.

By Col. M. A. Downing, Indianapolis.

After an unsatisfactory experience with untreated red cedar blocks, on sand foundations, four streets were paved, in 1896, with red cedar, treated with 3 lbs. creosote per cu. ft., and laid on a 1-in. sand cushion placed on concrete. The joints were filled with paving pitch. Next, long leaf pine blocks, 4 ins. deep, treated with 10 lbs. of creosote per cu. ft., were used. Some of this has been down three years and has stood well. The latter class of paving costs from $2.10 to $2.50 per sq. yd. in Indianapolis. It is less noisy than brick or asphalt, and costs less for cleaning—because cleaned less often. He believed creosoted hard woods were more durable than asphalt or brick and nearly as durable as granite.

Brick Pavements in Various Cities.

By L. M. Hastings, Cambridge, Mass.

After a tour of investigation of various cities and manufactories Mr. Hastings had recommended, where brick is to be used in Cambridge, a vitrified repressed shale, on 6 ins. of cement concrete, with a 2-in. sand cushion; joints to be filled with Portland cement grout, and expansion joints of asphalt to be provided at intervals; the city to do all the work and to require other underground work in the street to be done in advance of the paving; and that any openings in the finished streets should be at the expense of the parties making the same.

A general discussion of the papers on paving thus far read then ensued. Mr. Thompson, of Peoria, believed Portland cement a failure as a filler for brick, owing to the expansion of the cement, the consequent raising or arching of the brick, which may result in breaking or in the rumbling of the pavement. Sand, tar or asphalt fillers tend to reduce noise. Tar, however, is soft in summer and brittle in winter. Sand on steep grades washes out, but may be used on grades not steeper than 4 or 5%. On admissible grades, he recommended sand on account of its cheapness, but otherwise he preferred an asphalt mixture, prepared by some of the asphalt companies. In answer to a question, he said he did not think moisture would penetrate sand fillers.

Mr. Tillson did not believe asphalt strips along the curb would prevent rumbling of brick pavements, nor that the expansion of cement joints was material in amount. Mr. Adam said such expansion had been evident in Newark. Nevertheless, he believed cement filled joints would give five years longer life to a pavement than sand or mastic fillers. Mr. Tillson agreed with Mr. Adam.

Some Experience with Portland Cements.

By W. K. Eldridge, Lafayette, Ind.

Sulphate of lime is now being added to cements, in some cases, to age it. The addition tends to render some of the usual tests valueless, such as time for setting and boiling water tests. The permissible amount of sulphate of lime was placed at 2%. Cement may be tested for carbonate of lime by observing whether an effervescence is caused by hydrochloric acid. Then, after filtering to remove silicate, barium chloride may be used to precipitate sulphate of lime.

Slag cements are especially unsatisfactory for sidewalks, the ground basic slag being unstable in composition and such sidewalks disintegrating on exposure to air. Adulteration with slag may be detected, roughly, by the use of a magnet. He had first found steel or iron, indicating slag, in German cements, and later in two American brands.

Paving Between Street Railway Tracks in Toronto.

By C. H. Rust, City Engineer.

Asphalt has been found unsatisfactory for paving between tracks, cracking badly along the rails. Granite, scoria block and brick are being used to replace asphalt in such positions. Thus far, $137,000 has been expended in these changes, and soon all the asphalt between tracks will have been replaced by other material. The three materials now used are adapted to suit local conditions. Granite is the most durable, but wheelmen object to it. Canadian brick are used where the traffic is light.

Report of Committee on Water-Works and Water Supply.

By. M. R. Sherrerd, M. Am. Soc. C. E., Newark, N. J.

The committee believed that municipal ownership of water-works is now almost universally conceded to be advisable. It sounded a note of warning against the attempts being made in several quarters to corner available water supplies in the interest of private corporations. As a safeguard, present supplies should be conserved and waste prevented. The introduction of a comparatively few meters in Newark, N. J., has materially reduced the consumption. A proper allowance for use and unavoidable waste water in American cities is 50. to 60 gallons per capita.

The Albany Filtration Plant.

By Allen Hazen, Assoc. M. Am. Soc. C. E., New York City.

A series of lantern slides was shown, including a number of recent date showing the work of finishing the filters and the plant in operation.

Report of the Committee on the Disposition of Garbage.

By Dr. W. C. Woodward, Washington, D. C.

This report covered much the same ground as the one presented by Dr. Woodward at Syracuse last month, before the meeting of the League of American Municipalities (see Eng. News, Sept. 28, 1899). The committee recommended that scavenging work be done at public expense, without contractors. The report was followed by an account of garbage collection and disposal in Cincinnati, O., by Mr. August Herrman. (See Eng. News, Oct. 8, 1896, for full description of the Cincinnati methods and plant.) Short papers by Mr. John Jones, Street Commissioner, and Mr. Coatsworth, City Commissioner, of Toronto, were read describing street cleaning, garbage collection and disposal in that city. In 1898, there were collected 116,000 loads of refuse of all sorts, of which only 13,085 loads were classed as garbage proper. Practically all garbage from hotels and large boarding houses is collected by private scavengers, and many householders burn their garbage. Dead animals are also removed privately. Aside from this, all refuse matter is collected by the city, which also cleans and waters the streets. Ashes are kept separate from other house wastes, but otherwise there is a general mix up. The total cost of handling all material removed in 1898 was $62,482, which was 54.1 cts. per load and 27.17 per capita. There are two crematory plants, each composed of two large, independent furnaces, one stack serving each pair of furnaces. There is but one grate. One furnace was built for a capacity of 100 and the other for 120 cu. yds. They cost about $1,500 each, including buildings. Thus far this year about 33,000 cu. yds. (not loads) have been burned at a cost of 22 cts. per yd. About two tons of soft coal screenings per day are used at each furnace, the dry refuse collected assisting in combustion. The furnaces were designed by Mr. Coatsworth.

Other Committee Reports.

Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., Chairman of the Committee on Review, presented notes from a large number of municipal reports. The substance of many of these notes have been presented in past issues of this journal.

The Committee on City Government and Legislation, and the one on Municipal Franchises, requested more time, and the Committee on Coatings for Iron and Steel Pipes had not been heard from.

Miscellaneous Matters.

The election of officers resulted in the choice of Mr. A. D. Thompson, City Engineer of Peoria, as President; Mr. D. L. Fulton (re-elected), of Allegheny, Pa., Secretary; and Mr. F. J. O'Brien, Oswego, N. Y., Treasurer. Milwaukee was selected as the place for the next meeting.

One forenoon was devoted to a trolley ride, through the courtesy of the Toronto Street Railway Co., of which Mr. E. H. Keating, M. Am. Soc. C. E., is now manager. On another forenoon the city treated the delegates to a coach ride. A number of delegates, through the courtesy of Mr. S. Whinery, M. Am. Soc. C. E., visited the new asphalt plant of the Warren-Scharf Co., in Toronto. An exhibit was made of the Du Gary automatic catch-basin cleaner in operation.